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POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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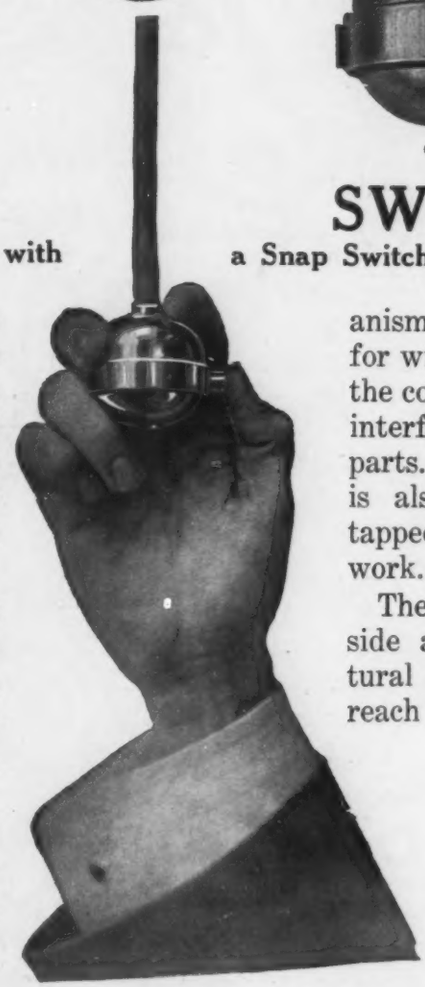

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Alphabetical Index to Advertisers, Page 8. Where to Buy It in the West, Pages 9,10,12.

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JOURNAL OF ELECTRICITY
POWER AND GAS
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VOLUME XXVII SAN FRANCISCO, DECEMBER 2, 1911 NUMBER 23

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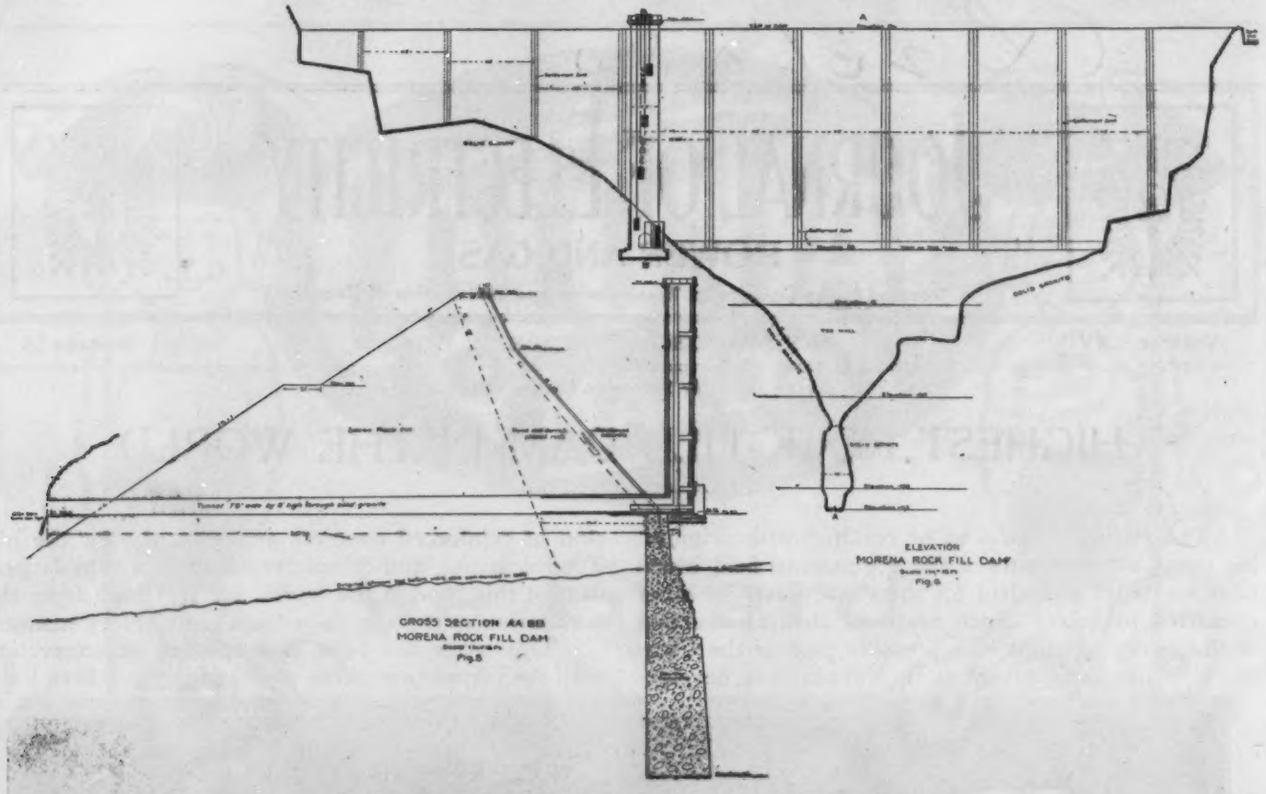
HIGHEST ROCK-FILL DAM IN THE WORLD

The Pacific slope is to be credited with originating many achievements in the engineering field which have created a precedent for the effete East and other countries to copy. Such feats as the construction of the heavy wrought iron pressure pipe of the Comstock in the early seventies in Nevada; the development of the Halliday cable street railway system in San Francisco; the creation of the thin arch dam of Brown in Bear Valley, San Bernardino County. The many pioneer rock-fill dams with wooden facing constructed in the old mining days in the California mountains, are now being surpassed by the modification of the same in the completion of the immense Morena rock-fill dam of San Diego which substitutes a veneered skin of reinforced concrete and masonry for the old wooden facing, and completes successfully the largest dam of this type in the world, 267 feet high from the foundation to the top, in a most satisfactory manner.

This work has been accomplished in connection with the completion of the works of the Southern California Mountain Water Company supplying the city of San Diego with water, owned by the brothers, John D. and Adolph Spreckels, residents of San Francisco. The city of San Diego has developed an extraordinary growth of population in the last twelve years, increasing from 17,000 people in the census of 1890 to 55,000 people at the present time. The supply of water to meet this growing population demanded

The Highest Rock-Fill Dam in the World Showing Outlet Tower



Morena Rock-fill Dam in Cross-section and Elevation.

prompt and heroic measures and the owners of this property, broad enough to realize the situation, undertook to build a number of storage dams to develop a reserve supply and anticipate the demand for water in the growing community.

This was rendered necessary owing to the fact that in this extreme southern end of the State of California, a number of dry years often appear in succession when the run-off from the mountain streams is very light, consequently large volumes of water must be impounded in the years of plenty to take care of the consumption and evaporation during the intervening lean years of light rainfall.

This company has now completed the following dams for impounding rainfall from the mountain watersheds:

RESERVOIR SUPPLIES OF THE SOUTHERN CALIFORNIA MOUNTAIN WATER COMPANY.

Name of Reservoir.	Type of Dam.	Height Feet.	Outlet Altitude.	Area Acres Submerged.	Capacity in gallons.
Lower Otay	Rock-fill	150'	400'	869'	13,000,000,000
Upper Otay	Arched concrete	77'	521'	164'	1,090,000,000
Chollas Hgts.	Earth and Steel Plate	34'	385'	17'	90,000,000
Morena	Rock-fill	265'	2912'	1370'	15,000,000,000
Total capacity					29,180,000,000

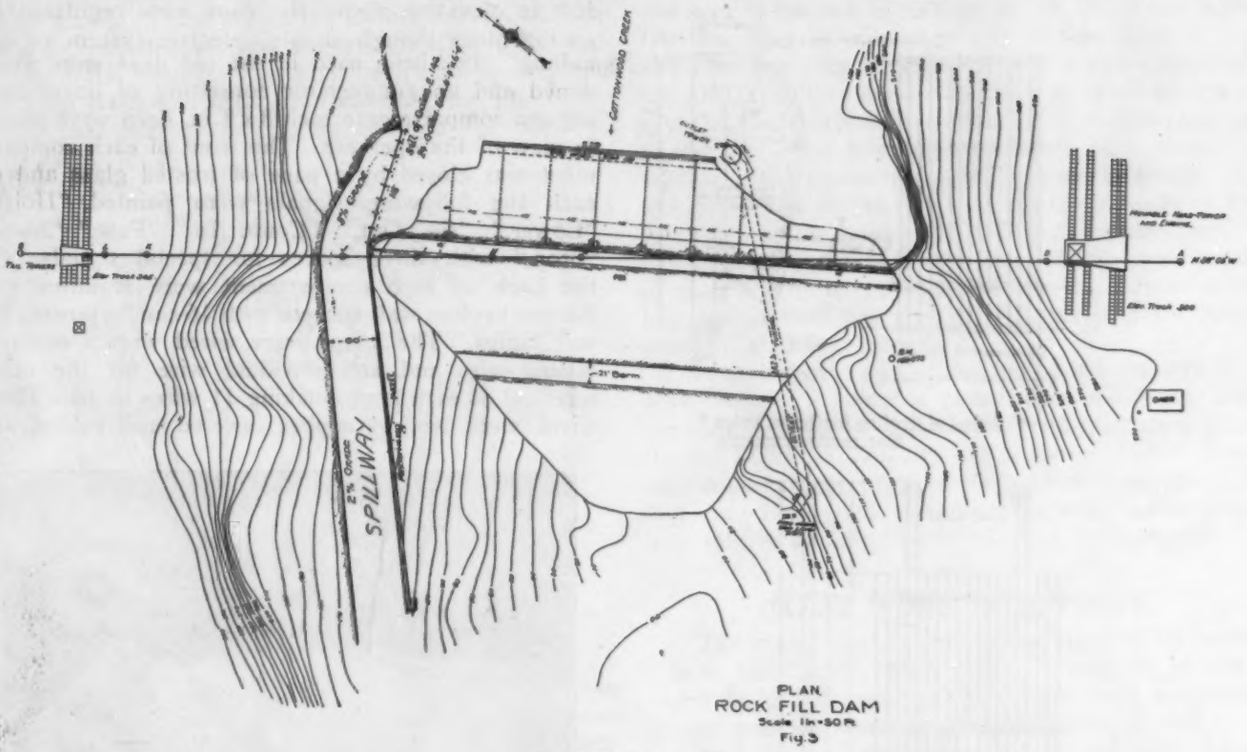
It will be seen that the little city of San Diego has now a reservoir capacity for its population of 55,000 almost equal to that of the Spring Valley Water Works system of San Francisco with over 400,000 population, and above four times that of the Peoples Water Company of Oakland, supplying Alameda and Berkeley with a combined population of about 300,000 people. There are many other sheds in San Diego within range of 30 miles of the coast, capable of being developed so that it can safely be said that water for a population of two and a half million can be conserved by intelligently making proper outlays, as numerous dam sites are available. The summit of the mountain range is about fifty miles from the coast at an altitude of from 4000 to 6000 feet, and the annual rainfall in this locality varies from 20 inches to 40 inches, depending on the contour of the mountains and the direction of the prevailing rainstorms which invariably float in from a southwesterly direction from the Pacific Ocean.

Morena Rock-Fill Dam.

This is located on the Cottonwood stream, which flows into the ocean near Tia Juana on the Mexican frontier. It is thirty-five miles in an air line south-

Morena Dam, Looking West.

east from San Diego and about seven miles north of the Mexican boundary line, past which the San Diego & Arizona Railway is now being built through the old town of Campo, which was a stage station of the

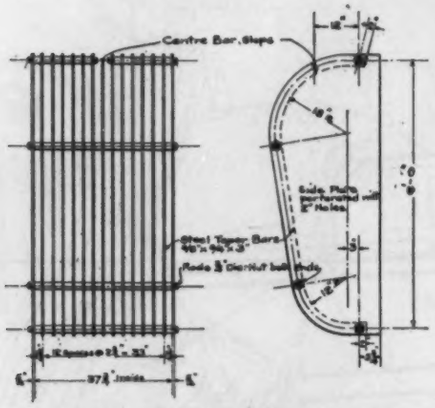


Plan of Rock-fill Dam.

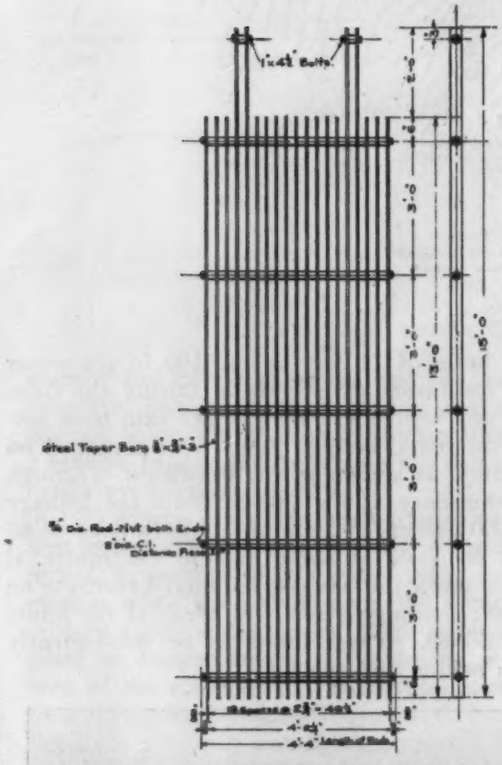
old overland wagon road in the early days before trans-continental railways were built. The dam is a rock-fill structure facing a narrow canyon gouged out of the solid granite cliffs that tower 500 feet high on each side of the gorge. This canyon is filled with enormous boulders throughout and in excavating the foundations at the site of the dam, a narrow fissure eroded by the ancient stream was found to be 112 feet below the stream bed at that point. A wall of rubble concrete 36 feet at the bottom and 12 feet thick 30 feet above the stream bed was the first construction done in 1896 when the project of building this dam was launched. Work was suspended with the toe wall up to the 30 foot contour in April, 1898, when about 120,000 cubic yards of rock-fill had been placed out of a total of 306,000 cubic yards required to complete the dam to the prescribed cross section. Work was resumed again after an elapse of eleven years by chief and consulting engineer M. M. O'Shaughnessy, Mem. Am. Soc. C. E., who, after a careful study of the situation, decided to change the upper slope from the top of the completed toe wall up to the 120 foot contour to 9 horizontal to 10 vertical and from the 120 foot contour to the top of the dam at the 150 foot level ½ horizontal to 1 vertical. In the new work of filling, it was decided to alter the character of the same by placing large six and ten ton blocks of granite on the up-stream face of the dam and have them well bedded and set in cement mortar of one cement to 2½ sand, and behind this masonry skin for a width of 50 feet to hand and derrick place all the stone and spall the same with small rock so that no cavities would exist in the structure. The top of the dam is 16 feet wide and crowned with a three-foot concrete coping for wave wash, and the back slope is 1½ horizontal to 1 vertical with a berm of 21 feet at the 100 foot contour to provide for future extensions in raising the dam. To obviate any serious cracking of the skin from settlement of the mass, vertical joints were arranged on 48-foot centers, as shown in the drawings. Through the rubble masonry at the present time the leakage is only 33,000 gallons in 24 hours under a head of 65 feet. It is proposed at some time in the future, if necessary, to put a thin slab of reinforced concrete on the top of the masonry which will break at the joints before mentioned. These joints to be subsequently calked with oakum and asphalt.

Upper Otay Dam.

As the freights from San Diego to Morena—a distance by wagon road of about sixty miles, with grades of 16 per cent and sometimes 18 per cent to overcome—cost up to about one cent per pound, it was imperative to diminish the quantity of expensive hauling to a minimum; hence the type of construction here described has been developed.



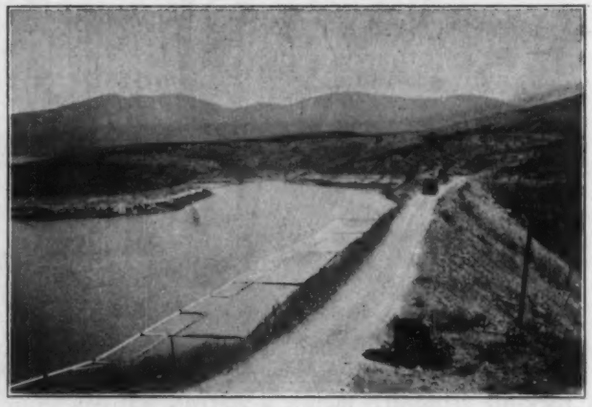
Detail of Grating for Outlet Valve
Four wanted complete



Detail of Grating for Mud Gate
One wanted complete

Possibly one of the most successful mass shots ever made with blasting powder was accomplished on this work August 30th, 1909, when 16¼ tons of powder in a chamber at the end of a tunnel drift 115 feet long broke 180,000 tons of granite rock at a cost of 4¼ cents per ton. This rock was afterward handled and placed in the dam by means of two Lidgerwood cableways, one 2½ in. in diameter, 1350 feet long and the other 2½ in. in diameter, 1100 feet long, which were able to pick up rock from 10 to 12 tons and convey them into the dam at a speed of about 300 ft. per minute. Five stiff legged derricks and two guyed derricks were used for placing rock in the skips and cables at the quarries and distributing them over the dam. Great care was used in keeping the derricks properly guyed to avoid breakage, as hauling supplies for renewals over the 60 mile road was somewhat expensive.

The control of the cables, which were about 200 feet in elevation above the dam were regulated by an ingenious though simple, electric system of signalling. The bells used in the old days were abandoned and an annunciator consisting of boxes having ten compartments each 8 x 8 in. deep were placed in view of the operator. The front of each compartment was closed by a pane of frosted glass and on each the following signals were painted, "Hoist," "Lower," "Go Out," "Come In," "Fast," "Slow," "Stop," with three spares for special signals. On the back of each compartment were mounted two Edison keyless wall sockets with 16-candle power, 110 volt lamps. The lamps were wired with a common return wire and an individual wire for the other terminal of each lamp, making 11 wires in all. These wires were No. 14 copper covered and cabled and

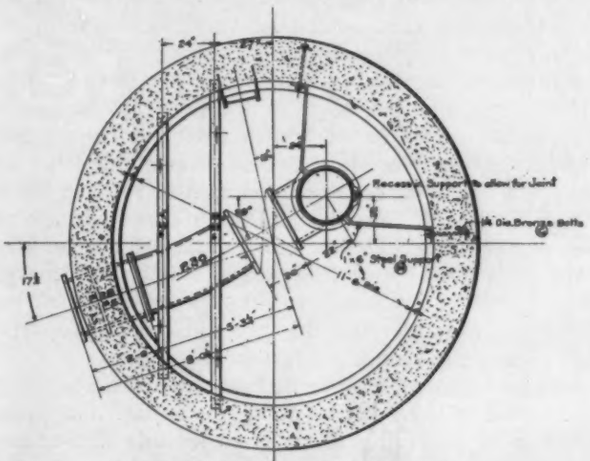


Lower Otay Dam.

the outside was protected by jute braid. Each flexible cable was 650 feet long and could readily be moved to any favorable position on the south or operating end of the dam. At the signalling end of the cable ten switches were mounted and normally held open by means of a spring requiring the pressure of the operator's fingers to close it. Switches were mounted upon an insulated base in such a way that the leads were brought into them without coming into contact with the wooden frame work. A 1¼ kw. 125 volt direct current compound wound generator was used to operate at a speed of 1650 r.p.m., which was driven by one C. H. Dutton 5 h.p. vertical type steam engine which was installed to operate at a speed of 300 r.p.m. This engine was supplied with steam tapped from one of the boilers of the big Lidgerwood engines. By this means a single man with the switch signal board was moved around the dam to the most effective points for observing the control and placing of rock as the work progressed, without interfering with guy wires and absolutely preventing accidents, as not a man was injured in 2½ years' operations from any confused signals.

The outlet arrangement consists of a reinforced circular concrete tower placed on bedrock in the reservoir basin and connecting with a tunnel 387 feet long, 8 feet wide by 7½ feet high, through which the water from the reservoir is drawn off. The outlet tower is 15 ft. 6 in. in external diameter, the concrete walls of which vary in thickness from 3 feet at the base to 20 in. at the top. The top of this tower is at an elevation of 155½ feet, on which an operating

deck of reinforced concrete is built for regulating the outer gates. These are of the Coffin Valve Company sluice type with vertical stems controlled by guides let into the concrete. Around each gate is a screen to keep trash and drift from entering the 24 in. circular cast iron pipes passing through the walls of



Horizontal Section of Tower on Line AA
Gate "B." Scale 1/8 = 1 Foot.

the tower and connecting with a 30 in. vertical down pipe which discharges into the tunnel before mentioned. These outlets are located 28 feet apart vertically, so that the water may be drawn off under a light head from any of these levels. Between each opening and the down pipe there is a curved removable bolted flanged casting to enable the gates to be easily removed, if it is ever found necessary, and which is attached to Crane gates operated from platforms inside of the tower at the different levels, and which are used for emergency purposes only. The admission of water through the outer sluice valves relieves the leaf valves from any chattering effect developed by the spouting water which discharges into the down pipes flowing freely through the tunnel. There is also an independent 24 in. cast iron pipe which will be used for washing out the sediment which may in the future accumulate near the base of the outlet tower and which passes through its foundation and connects with the tunnel before mentioned. The inner 75 feet of this tunnel in solid granite—has been lined with concrete and connects with the base of the tower and encloses the pipes which discharge onto the floor of the tunnel, so that every precaution has been taken to have as simple and safe an outlet at a moderate expense as it was possible to obtain. From the outer end of this tunnel the water will be permitted to flow at present along the natural grade of the Cottonwood Creek until it is picked up above the Barrett dam site by the Dulzura Conduit which leads the water to the Otay reservoir.

This design of tower was decided upon after a prolonged study of many different types of outlet, and the fact that a similar one is now being built in Alabama is another tribute to the achievements of our western engineers in ignoring precedent and threshing out problems to logical conclusions.

In order to obtain a comparison with other similar engineering structures, a brief description of the Roosevelt Dam, Arizona, is here given:

It is of solid masonry and at its base occupies one acre of the bed of Salt River. It is 280 feet high, 170 feet thick at river bed and 16 feet thick at top and 1080 feet long at crest, it took 4 years to build, has 340,000 cubic yards of masonry in its contents and cost the Reclamation Service of the U. S. Government $3,468,000. The Morena is 267 feet high from the bottom of the foundations—which were excavated 115 feet below the old stream bed—to the top. It is 300 feet thick at the base and 550 feet along the crest, it has taken 5 years to build, has 306,000 cubic yards of masonry in its contents, covers 2½ acres on its foundations, and has cost Mr. Spreckels' water company $1,500,000 to complete.

It backs the water up for four miles through Morena Valley, forming a picturesque mountain lake, the shores of which are studded with glistening granite and bordered with live oak trees—and as it is solidly united to the primeval bedrock with all the skill and care that good workmanship could accomplish, it is safe to assume that it will last until eternity.

CANAL WORK IN OCTOBER.

The grand total of Canal excavation to November 1 was 153,055,640 cubic yards, leaving to be excavated 42,267,739 cubic yards, or less than one-fourth of the entire amount for the completed Canal.

The total for October was 2,331,678 cubic yards, as compared with 2,884,382 cubic yards in October, 1910, and 2,827,798 cubic yards in October, 1909.

The dry excavation amounted to 1,516,759 cubic yards, and was principally by steam shovels. The dredges removed 810,215 cubic yards, and 4,704 cubic yards were sluiced in the Central Division, in addition to the amount pumped into Gatun Dam by suction dredges. The progress on the locks at Gatun, Pedro Miguel, and Miraflores is referred to elsewhere in this issue.

In the Atlantic Division, the total excavation was 536,431 cubic yards. Of this total, 66,031 cubic yards were dry excavation, and the remainder was removed by the dredges in the Atlantic entrance.

The total excavation in the Central Division was 1,319,187 cubic yards, all of which was from the prism. The amount taken from Culebra Cut was 1,306,971 cubic yards, as compared with 1,320,314 cubic yards in October, 1910, the high record for that month.

In the Pacific Division, the total excavation was 476,060 cubic yards, 339,815 cubic yards of which were taken out by dredging at the Pacific entrance.

BURNING OF AN ELECTRICALLY OPERATED GOLD DREDGE.

Yuba Consolidated gold dredge No. 10 was burned last week, at the dredging grounds on the Yuba River above Marysville. It was recently completed at a cost of $200,000 and was insured for quite an amount. As no one was on board the dredge when the fire started, the cause of the disaster is not definitely known. The company made an excellent showing during the past year and the construction of another dredge is only a question of time.

MUNICIPAL ELECTRIC LIGHTING SYSTEMS[1]

BY C. L. CORY.

At the last meeting of the San Francisco Section of the American Institute of Electrical Engineers, at which Honorable Max Thelen, attorney for the California Railroad Commission, made an address in connection with the recently adopted amendments to the Constitution of the State enlarging the powers of the railway commission and extending their control over other public service corporations than steam and electric railways, it was brought out that in the State of Wisconsin its railroad commission has practically the same control over the construction, operation and rates for service of the municipally owned public utilities as over the privately owned corporations providing service to the public.

Since the most valuable work has been done by it, and especially, since the decisions of the Wisconsin Railroad Commission have been almost universally adopted, at least in principle, it is certainly desirable to most carefully consider the important opinions and findings of this commission in the principal cases it has considered and especially the decisions it has rendered.

Such conclusions are of necessity in the form of generalities rather than specific instances, and, while it should be fully understood that the conditions in Wisconsin may and probably are very different from those existing in California, the application of these conclusions to two typical electric lighting systems in two different Pacific Coast cities give results which are certainly illuminating.

In arriving at a basis for a just fixing of rates, this commission has consistently maintained that the rates for current should be based upon the cost of the service.[2] Each consumer occasions expenses to the plant. In order that every consumer shall pay his just share of the expenses, it is necessary to apportion the expenses of the plant between the capacity and output costs, and determine what part of each class of expense should be charged against each particular consumer. Thus, a particular consumer installs in his residence thirty incandescent lamps, thereby necessitating the power plant to be ever ready to supply the necessary current should the consumer turn on all his lights. The particular consumer, however, except in rare instances burns only four lamps for a few hours each day. The consumer has thus forced the power plant to install sufficient capacity to care for maximum load conditions and should be charged a proper amount for this constant or capacity expense and also should pay a proper charge for the actual service rendered. Some eastern meters are installed so as to register these separate factors. It is then seen that operating expenses are of two classes—constant and variable.

Constant expenses are not affected by the business done but depend more on the capacity of the plant rather than any other factor. The variable expenses depend upon the amount of service rendered. The fixed or constant expenses should as nearly as is possible be charged proportionally for maximum capacity of each consumer while variable charges should be proportionally to the amount of service rendered.

The Wisconsin Railroad Commission in numberless decisions maintains that in the accounts of a public service corporation provision must always be made for depreciation. Depreciation is defined as that loss or shrinkage of value which inevitably occurs from time to time in the equipment of the plant, as a result of the employment of this equipment in the production of electricity. The loss may be due to wear and tear, to age, to the march of modern invention, or to the inadequacy or to any or all of these causes combined. The aim of a depreciation fund is in a word to keep the investment intact. Repairs and maintenance do not offset depreciation. Depreciation must always be taken care of in the operating costs which are charged directly to the consumer and not charged against construction, thus warping this account out of proportion and apparently showing large earnings.

The commission goes further and states that as depreciation is continually going on a just and proper method of providing for it is to include depreciation under the head of operating expenses, charging off to the constant expense account such proportion of the depreciation as rightfully belongs under this heading and to the variable expense account such proportion as properly belongs under its heading.

In the course of its investigations the commission found it necessary in cases of improperly arranged accounts or in case of no accounts being kept at all to order properly classified and detailed reports of expenses for the future.

Furthermore in the matter of municipal plants the commission found certain cases in which the accounts showed that taxes were not assessed against these plants and consequently the commission put itself on record as opposed to such practice. The commission stated that as capital invested in a public plant is the capital of the municipality or the taxpayers, the taxes and interest are a necessary factor in the determination of the cost of furnishing the service.

In order to apply the methods of approximately obtaining the cost of service to each customer, as is so clearly and completely set forth in the above quotations, I have worked out on two typical electric lighting systems on the Pacific Coast the segregated costs, setting forth separately the fixed and variable expense as affected by the load factor as well as the quantity of electrical energy used by each customer. System No. I has its power generated with steam, while System No. II receives its power at a substation outside of the city limits, stepping down from 60,000 volts to the voltage of distribution allowed within the city power.

Probably no point is of such serious consequence in connection with the operation of a municipally owned lighting system as the low load factor resulting from the fact that most of the electrical energy used is for residence lighting, the period of use being of probably not more than an average of two hours each night out of the twenty-four hour day. Again, the wide difference between the maximum demand or peak load and the average load for the year is caused by the difference in the seasons between December

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[1]Paper read before the Fourteenth Annual Convention League of California Municipalities.

[2]Wisconsin Railroad Commission Reports, Vol. 3, pages 299-321; Vol. 4, pages 219-229; Vol. 5, pages 560-574; Vol. 5, pages 742-791.

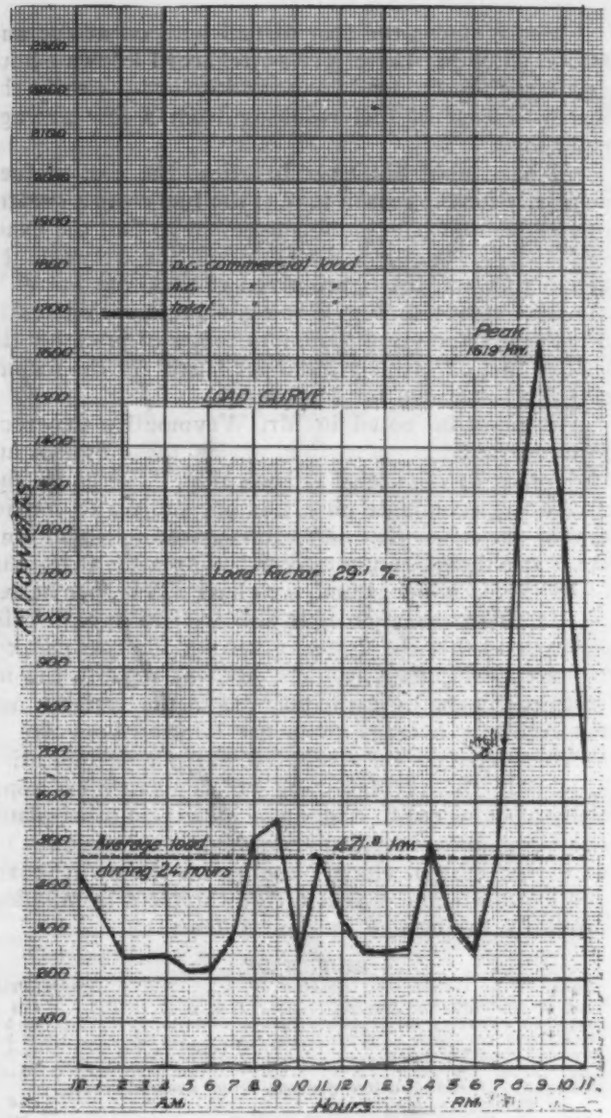

Fig. 1. Peak Load Conditions for Summer Months.

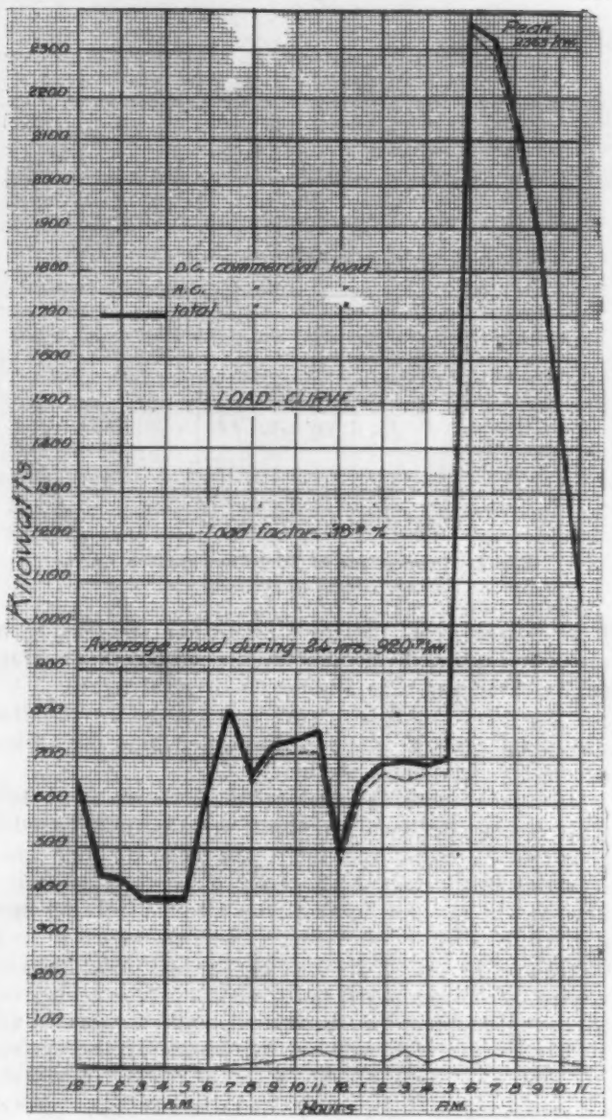

Fig. 2. Peak Load Conditions for Winter Months.

and June, and it is not extraordinary to find that the peak load for residence and retail business lighting during the last few days of December is 50 per cent greater than the corresponding peak load during the summer season. As an illustration of this Fig. 1 is the load curve of System No. II on June 30, 1910, showing a maximum load of 1619 kw. at 9:00 p. m., lasting for a very short time. In fact, the load above 1200 kw. was only of two hours' duration, or between 8:00 and 10:00 p. m. The average load for the twenty-four hours was 471.8 kw., making a load factor of 29.1 per cent for the day.

Fig. 2, on the other hand, is the load curve of System No. II six months later, or on December 31, 1910. The actual peak on this day was 2363 kw., or almost exactly 50 per cent greater than on June 30. This peak of practically 2400 kilowatts, occurred at 6 p. m. and lasted for the better part of an hour. The load above 1200 kw. continued for a period of 5½ hours, or between 5:15 and 10:45 p. m. The average load during the twenty-four hours was 920.7 kilowatt, or nearly 100 per cent greater than on June 30, six months previous. The load factor for the day was 38.9 per cent. While these curves are for particular days, yet they are typical of the summer and winter load, neither of them being abnormal for the two seasons. An annual load factor for such electric lighting service of from twenty to thirty per cent is not uncommon, while, in comparison, due to the large use of electrical energy for power in the operation of manufacturing plants, transportation systems, mines, etc., the load factor of extensive transmission systems, which often include a number of hydroelectric as well as steam driven central stations, have a load factor of between seventy and seventy-five per cent.

Another point of importance in connection with the construction and operation of municipally owned lighting systems is the rapid growth required of such systems in many progressive western cities. The increased investment demanded each year must be met ordinarily by a new bond issue and to show what this would mean in the city where System No. II is installed, I have given below the year, the additions to plant, and the total investment for a period of seven years. During this time the additions to the plant varied from a minimum of $35,000 to a maximum of

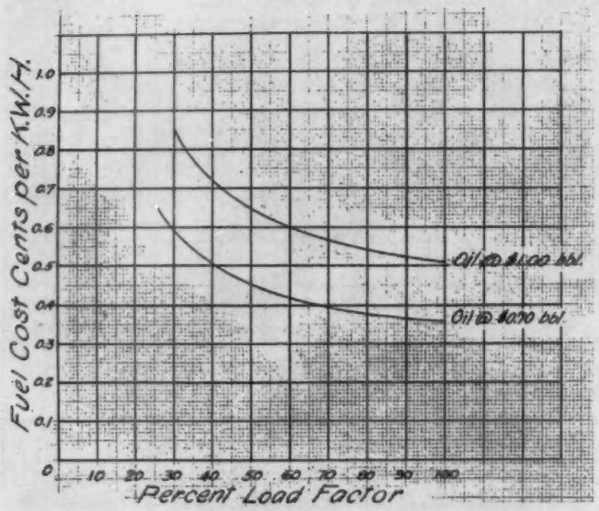

Fig. 3. Dependence of Fuel Consumption Upon Load Factor.

$120,000 per year, the total investment increasing in the seven years from $155,000 to $565,000, or practically three and a half times its original figure.

To meet this growth very many times requires additional money which ordinarily cannot be raised except by new bond issues.

Under favorable conditions, if there be a surplus, it may be used for short periods to do needed construction work and later, the cost of such construction work may be met by a bond issue, reimbursing the surplus fund of the electric lighting system from such bond issue. In such cases it may sometimes be proper to expend, for new construction, money which properly must be set aside each year to cover depreciation, provided such accounts are always properly carried on the books of the system so that the depreciation reserve, temporarily used for new construction, is replaced and used as required at such time as a new bond issue renders again available the funds actually and in reality required for extensions of the system and new construction.

INCREASED INVESTMENT IN SYSTEM.
SYSTEM NO. 11.

Year.	Additions to Plant.	Total Investment
First		$155,000
Second	35,000	190,000
Third	40,000	230,000
Fourth	95,000	325,000
Fifth	75,000	400,000
Sixth	120,000	520,000
Seventh	45,000	565,000

In determining the fuel cost on the steam plant switchboard per kilowatt-hour at different load factors I have used the figures given by C. R. Weymouth, M. E., in a paper entitled "A Method for Calculating Steam Power Plant Economy," for condensing direct connected steam driven units based on plants installed at Pacific Coast railway terminal points.

The kilowatt-hours per barrel of oil as there given for a 1500 kilowatt condensing plant operating 24 hours per day are as follows:

Load Factor.	Kw.-hr. per bbl. of oil.
12 hr. Test.	217
100%	197
50%	155
33 1/3%	125

Fig. 3 shows the cost of fuel with oil at 70c and also at $1.00 per barrel per switchboard kilowatt-hour as affected by the load factor and indicates clearly the increased cost of fuel resulting from a low average daily load.

I have used $1.00 per barrel as the cost of fuel, primarily for the reason that, if the fuel costs a greater or less amount it is quite convenient to find the exact fuel cost by taking a direct proportion between the actual cost and the figure given of $1.00 per barrel.

The curves of Fig. 3 show what is considered to be the maximum and minimum range of price for the cost of fuel oil, namely $1.00 per barrel for the former and 70c per barrel for the latter,

It must be noted in Mr. Weymouth's paper on Power Plant Economy from which these figures are taken that he is careful to state that, "The above figures are approximate only, and are subject to considerable variation, depending on operating conditions, etc.," and the oil is assumed as having a thermal value of 18,850 B.t.u. per pound, weighing 336 lb. per barrel.

In this connection it is also well to have it fully understood that the figures given for the two particular electric lighting systems, both as regards the investment in the different portions of the systems, and the resulting average costs per kilowatt-hour are to be considered as only relative and not as indicating absolutely the average costs per kilowatt-hour, especially as delivered to customers' meters, in other plants operating under decidedly different conditions as regards the cost of electric energy on the switchboard and character and extent of the complete installation, primarily in the distribution systems.

SYSTEM NO. 1.

Character of Generating Station	Steam Plant
Cost of fuel oil, per barrel	$ 1.00
Installed capacity	1,750 kw.
Peak load for year	1,200 kw.
Average load for year	415 kw.
Load factor for year	34.6%
Efficiency of distribution system from switchboard to customers' meters	65%
Aggregate length, distribution system	75 miles
Average cost of distribution system per mile	$ 3,430
Number of customers	3,057
Number of customers per mile of distribution system	41
Number of pole transformers	552
Aggregate capacity transformers	2,179 kw.
Average capacity per transformer	4 kw.
Total valuation system	$ 560,000
Kw.-hr. steam plant switchboard per year	3,635,500
Kw.-hr delivered to customers' meters per year	2,363,000
Average generating cost per kw.-hr steam plant switchboard	1.91c
Average generator cost per kw.-hr. delivered to customers' meters	2.94c
Average total cost per kw.-hr. delivered to customers' meters	6.32c

SYSTEM NO. 11.

Charter of Electric Service.	From water and steam power transmission system
Peak load for year	2,500 kw.
Average load for year	750 kw.
Load factor for year	33 1/3%
Efficiency of distribution system from switchboard to customers' meters	70%
Aggregate distribution system:	
Overhead	100 miles
Underground	4½ miles
Average cost distribution system per mile	$ 3,050
Number of customers	7,250
Number of customers per mile of distribution system	69
Number of pole transformers	424
Aggregate capacity transformers	4,167 kw.
Average capacity per transformer	10 kw.
Total valuation of system	$ 577,000
Kw.-hr. sub-station switchboard per year	6,570,000
Kw.-hr. delivered to customers' meters per year	4,600,000
Cost per kw.-hr sub-station switchboard:	
100% load factor	75c
20% load factor	2.25c
Cost at the sub-station switchboard per kw.-hr. delivered to customers: meters:	
30% load factor	3.21c
Average total cost per kw.-hr. delivered to customers' meters	6.34c

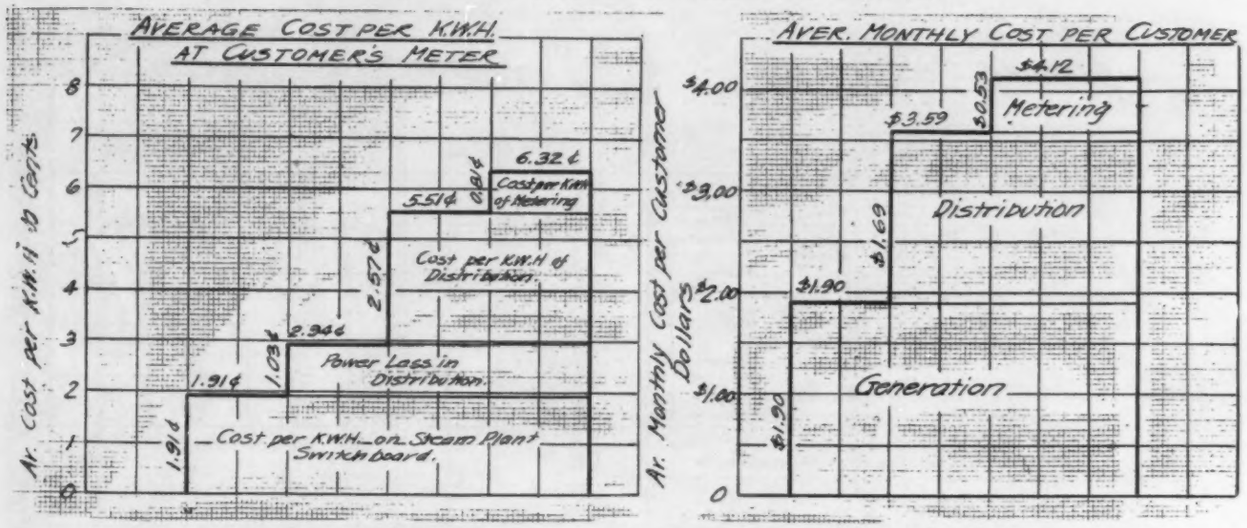

Fig. 4. Average Cost per kw.-hr. and Cost per Customer. System No. 1.

SYSTEM NO. 1.

Investment in Generating Station, Distribution System, and Electric Meters Per kw. Installed Capacity, Peak Load, and Average Yearly Load.

Portion of System.	Investment.	Investment per Kilowatt Installed. Capacity.	Peak Load.	Average Load.
Generating station..	$253,000	$144.44	$210.65	$609.50
Distribution system.	257,000	146.90	214.17	619.00
Electric meters	50,000	28.55	41.63	120.50
Total	$560,000	$319.89	$466.45	$1349.00

The relation between the investment per kilowatt in the generating stations, distributing system, and electrical meters, based on the peak load and the average load indicates clearly the disadvantage of a low load factor. When the total investment is as much as $1349 per kw. average load, and the investment in meters alone is $120.50 per kw. average load, it is easy to understand the causes of the higher fixed charges under such operating conditions.

SYSTEM NO. I.

Annual Station Charges and Cost Per kw.-hr. on Switchboard and Customers' Meters for Different Load Factors.

Item.	%	Yearly total	Per Kilowatt Hour. 100%	70%	35%
Interest	5%	$12,650	0.12	0.17	0.34
Taxes	1.6%	4,050	0.04	0.06	0.11
Depreciation	5%	12,650	0.12	0.17	0.34
Fuel			0.51	0.56	0.79
Operation and maintenance		12,000	0.11	0.16	0.33
Total generating cost per kw. at plant.....			0.90c	1.12c	1.91c
Total generating cost per kw. delivered to customers' meters			1.38c	1.73c	2.94c

In the above table the average rate of depreciation upon the generating station is taken at 5 per cent, which has been determined by considering separately the estimated life of the different parts of the station, including buildings, foundations, and the steam and electrical machinery. The total generating cost per kw.-hr. at the plant, it will be noted, is less than one-half as much at 100 per cent load factor as at 35 per cent load factor, the actual figures being 0.9c per kw.-hr., with the best character of load and 1.90c per kw.hr., with the average load a little more than 1/3 of the maximum of peak load.

SYSTEM NO. I.

Annual Distribution Charges and Cost Per kw.-hr. on Switch-Board and at Customers' Meters for Different Load Factors.

Item.	%	Amount	Per Kilowatt-Hour. 100%	70%	35%
Interest	5%	$12,850	0.12	0.17	0.35
Taxes	1.6%	4,120	0.04	0.06	0.11
Depreciation	8½%	21,850	0.21	0.30	0.59
Maintenance and operation		23,000	0.22	0.31	0.62
Total distribution cost per kw.-hr. at plant.....			0.59c	0.84c	1.67c
Total distribution cost per kw.-hr. delivered to customers' meters			0.91c	1.29c	2.57c

In the above table the annual depreciation for the distribution system has been taken at 8½ per cent and has been determined by estimating the life of the different elements of the distribution system, including poles, cross-arms, transformers, conductors, and other outside construction materials.

It is to be noted in this table that the total distribution cost per kw.-hr. delivered to customers' meters is nearly three times as great at 35 per cent load factor as at 100 per cent load factor, or 0.257c per kw.-hr. in the former case and 0.091c per kw.-hr. under the most favorable operating conditions.

Annual Metering, Billing and Collecting, Etc., Charges and Cost Per kw.-hr. on Switchboard and to Customers' Meters for Different Load Factors.

Item.	%	Amount	Per Kilowatt-Hour. 100%	70%	35%
Interest	5%	$2,500	0.02	0.03	0.07
Taxes	1.6%	800	0.01	0.01	0.02
Depreciation	8%	4,000	0.04	0.05	0.11
Maintenance and operation		12,000	0.11c	0.16c	0.33c
Total metering cost per kw.-hr. at plant			0.18c	0.25c	0.53c
Total metering cost per kw.-hr. delivered to customers' meters			0.28c	0.38c	0.81c

The total average cost per kw.-hr. delivered to customers' meters at 100 per cent, 70 per cent, and 35 per cent load factor in the above table, are, respectively 2.57c, 3.4c and 6.32 c, which comparative figures indicate clearly why the customer, using electrical energy, even though it is comparatively small in magnitude, is justly entitled to a decidedly low rate if the electric energy used by him is utilized at a high daily average

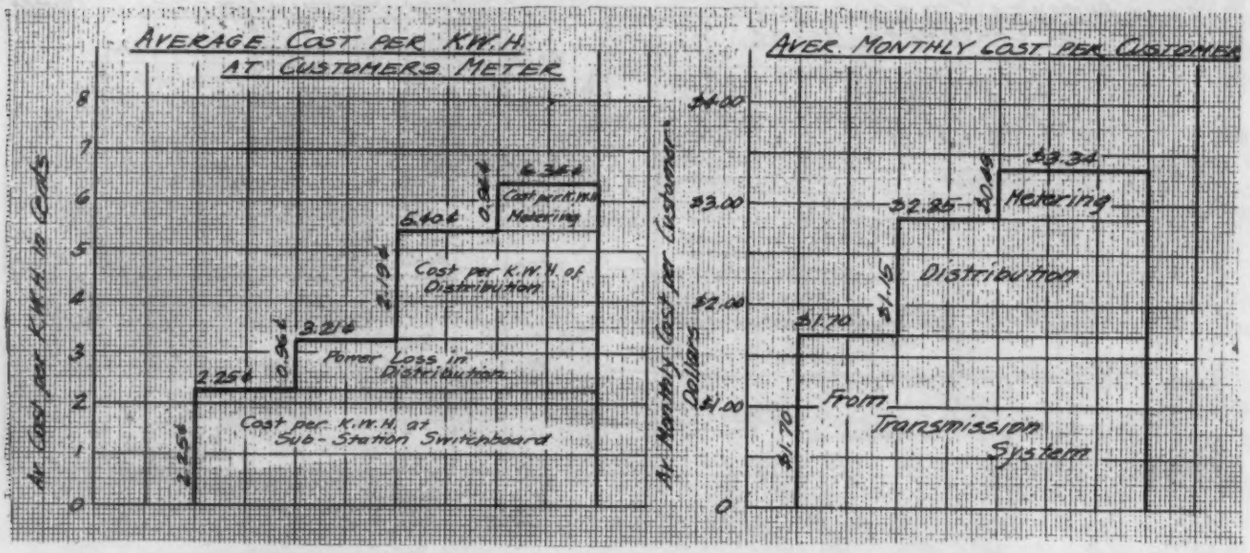

Fig. 5. Average Cost per kw.-hr. and Cost per Customer. System No. 2.

load, or in other words, if his demand for service is such that the load factor is high. In this instance, if the load factor is uniform throughout the 24 hours, his rate may properly be 2.57c per kw.-hr., increasing from this to 3.4c, if the average load is 70 per cent of the maximum, and finally to 6.32c if the average load is but 35 per cent of the maximum or peak load.

SYSTEM NO. I.

Total Cost of Electric Service Per kw.-hr. to Customers' Meters at Different Load Factors.

Item.	per Kilowatt-hour to Customer at 100%	70%	35%
Generation	1.38c	1.73c	2.94c
Distribution	0.91c	1.29c	2.57c
Metering	0.28c	0.38c	0.81c
Total cost (average)	2.57c	3.40c	6.32c

The figures in the last column are shown graphically in Fig. 4, which includes the average segregated cost of electrical service to customers in System No. I per kw.-hr. as well as the corresponding average monthly cost per customer. The average monthly bill in System No. I is $4.12, divided as follows:

Generation costs	$1.90
Distribution costs	1.69
Metering, billing, collecting, etc.	.53
Total	$4.12

It will be noted in the above that the cost of distributing the energy due to the fixed charges on the required investment, and losses in the distribution system and the comparatively low load factor, are not materially less than the corresponding cost of generating the electrical energy, while the cost of metering, billing, and collecting, per month, per customer, averages 53c, which is an indication at least of the necessity of a minimum bill whether current is used by the customer or not.

TOTAL INVESTMENT IN SYSTEM NO. II.

Substation—		
Real Estate	$22,000	
Buildings	33,500	
Apparatus	87,500	$143,000
Distribution—		
Overhead	$274,500	
Underground	44,000	318,500
Meters		115,500
Total		$577,000

SYSTEM NO. II.

Investment in Substation, Distribution System and Electrical Meters Per kw.-hr., Peak and Average Yearly Load.

	Total Investment	Investment per kilowatt. Peak Load 2500 kw.	Average Load 750 kw.
Substation	$143,000	$ 57.20	$190.60
Distribution	318,500	127.50	424.70
Meters	115,500	46.20	153.90
Total	$577,000	$230.90	$769.20

From the above figures it is to be noted that the total investment per kilowatt for the average load in System No. II is only a little more than one-half the corresponding investment in System No. I, this being due to the fact that there is no investment required for the generating station in System No. II. This is also shown in a rather striking manner by the fact that the total investment in System No. I for a peak load of 1200 kw. is $560,000, while the total investment in System No. II, not requiring a generating station, is but little more, or $577,000 for a peak load of 2500 kilowatts, or more than twice that of System No. I. This is true notwithstanding the fact that in System No. II there is a considerable portion of the distribution system underground, thereby requiring a relatively higher investment than for an overhead system of the same capacity.

SYSTEM NO. II.

Annual Distribution Charges and Cost per kw.-hr. on Switch-Board and at Customers' Meters for Different Load Factors.

Item.	Cost of distribution. Amount.	Per Cent.	100 miles of distribution system. Yearly Charge.	Cost per kw. hr. 100%	70%	30%
Interest	$461,000	5%	$23,050	0.11c	0.15c	0.35c
Taxes	461,000	1.6%	7,376	0.03c	0.05c	0.11c
Depreciation—						
Buildings	33.500	3%	1.005			
Electrical apparatus	87,500	5%	4,375			
Distribution: Overhead	274,500	8½%	23,333			
Underground	44,000	4%	1,760			
	$439,500	6.94%	$30,473	0.14c	0.20c	0.46c
Maintenance and operation	$40,000			0.18c	0.26c	0.61c
Total distribution cost per kw.-hr. at sub-station				0.46c	0.66c	1.53c
Total distribution cost per kw.hr. delivered to customers' meters				0.66c	0.94c	2.19c

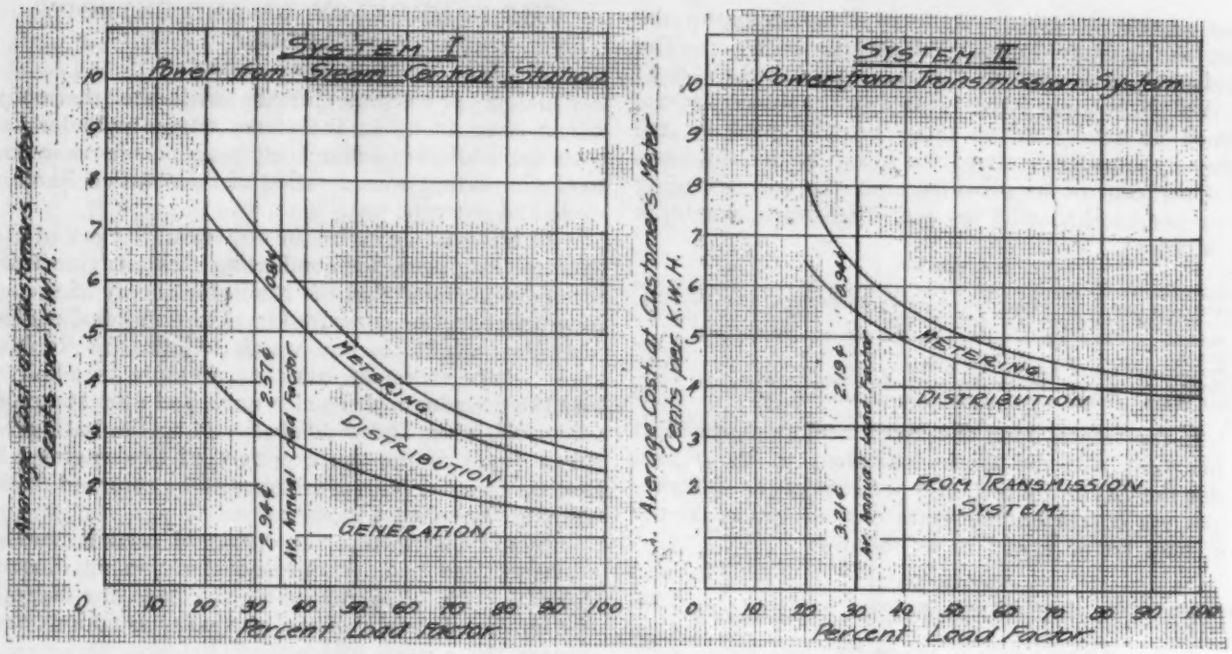

Fig. 6. Comparison of Power From Steam Central Station as Opposed to Power From Transmission System.

From the above table the distribution cost per kw.-hr. delivered to customers' meters at 100 per cent load factor—0.66c is less than 1/3 of the corresponding distribution cost at a load factor of 30 per cent, which clearly indicates the reason why rates for electric service for a low average load as contrasted with the maximum load, are materially higher than for a load approximating 100 per cent load factor.

SYSTEM NO. II.

Annual Metering, Billing and Collecting, etc., Charges, and Cost per kw.-hr. on Sub-Station Switchboard and at Customers' Meters for Different Load Factors.

Item.	Amount.	Per cent.	Yearly charge.	Cost per kilowatt-hour. 100%	70%	30%
Interest	$115,500	5%	$ 5,775	0.03c	0.04c	0.09c
Taxes	115,500	1.5%	1,850	0.01c	0.01c	0.03c
Depreciation	115,500	7%	9,240	0.04c	0.06c	0.14c
Maintenance and operation			26,000	0.12c	0.17c	0.40c
Total metering cost per kw-hr. at sub-station				0.20c	0.28c	0.66c
Total metering cost per kw.-hr. delivered to customers' meters				0.28c	0.40c	0.94c

The figures of the above table have been used to show graphically, as per Fig. 5, the average segregated cost of electric service to customers in System No. II per kw.-hr., and also per month. In this system the cost of electric energy from the transmission lines represents an average monthly cost to customer of $1.70. The corresponding distribution cost, $1.15 and the metering, billing and collecting 49c, or a total average monthly cost per customer of $3.34. The average cost per kw.-hr. at customers' meters is practically the same in System No. I and in System No. II, namely, 6.32c and 6.34c, respectively. The corresponding average monthly cost per customer is considerably less in System No. II, than in System No. I, as a result of the greater number of meters, or customers in the latter case.

Fig. 6 shows for both systems the variation of the generation cost, in the one case, and the cost of electrically transmitted power in the other, and for both cases, the distribution and metering costs per kw.-hr average to customers' meters at different load factors. The effect upon the rate per kw.-hr at low load factors and the necessity of increasing this rate in such cases is clearly shown by the curves for both systems.

SYSTEM II.

Total Cost of Electric Service per Kilowatt-Hour to Customers' Meters at Different Load Factors.

Item.	Cost per Kilowatt-Hour at Customers. 100%	70%	30%
Cost of power at sub-station	1.07c	1.50c	3.21c
Distribution	0.66c	0.94c	2.19c
Metering	0.26c	0.40c	0.94c
Total	2.01c	2.84c	6.34c

Annual and Monthly Costs per Customers.

SYSTEM NO. I.

	Per year.	Per month.
Average cost of electric energy at steam plant switchboard per customer	$22.71	$1.90
Average cost of electric distribution per customer	20.22	1.69
Average cost of metering, billing and collecting per customer	6.31	0.53
Combined cost of electric distribution, metering, billing and collecting per customer	26.53	2.22

SYSTEM NO. II.

	Per year.	Per month.
Average cost of electric energy at sub-station switchboard per customer	$20.39	$1.70
Average cost of electric distribution per customer	13.91	1.15
Average cost of metering, billing and collecting per customer	5.90	0.49
Combined cost of electric distribution, metering, billing and collecting per customer	19.81	1.64

In the determination of costs as given above, interest has been assumed as 5 per cent on the investment corresponding approximately to the interest charge on investments made by municipalities as a result of bond issues. Taxes have been considered at 1.6 per cent per annum, corresponding to an assessment of 50 per cent on the valuation and a tax rate of $3.20 per $100 assessed value.

If the return upon the investment is assumed as that to which a privately owned public service corporation, furnishing electric light and power to the inhabitants of a city, is entitled, as per the decis-

ions of the Wisconsin Railroad Commission in the case of the State Journal Printing Company vs. The Madison Gas & Electric Company, page 648 W. R. C. R. Vol. 4, namely 8 per cent and the taxes are assumed as equivalent to those actually paid by the company owning System No. I, kw.-hr. on the basis of 4 per cent of its gross receipts the corresponding costs per kw.-hr. at 35 per cent load factor, would be as follows:

SYSTEM NO. I.

Generating costs per kw. at plant	2.16c
Generating costs per kw. delivered at customers' meters.	3.33c
Distribution costs per kw.-hr. at plant	1.91c
Distribution costs per kw.-hr. delivered to customers' meters	2.94c
Metering costs per kw.-hr. at plant	0.58c
Metering costs per kw.-hr. delivered to customers' meters	0.89c
Total costs per kw.-hr. delivered to customers' meters	7.16c

If the return upon the investment is assumed at 8 per cent and the taxes equivalent to those paid under the California law, of 4 per cent of the gross receipts the corresponding costs per kw.-hr. at 30 per cent load factor would be as follows:

SYSTEM NO. II.

Cost per kw.-hr. at sub-station switchboard	2.25c
Sub-station cost per kw.-hr. when delivered to customers' meters	3.21c
Distribution costs per kw.-hr. at sub-stations	1.78c
Distribution costs per kw.-hr. delivered to customers' meters	2.54c
Metering costs per kw.-hr. at sub-stations	.72c
Metering costs per kw.-hr. delivered to customers' meters.	1.03c
Total costs per kw.hr. delivered to customers' meters	6.78c

Comparative Cost per Kilowatt-Hour, First, With Return on Investment 5%, Taxes 1.6%, and Second, Return on Investment 8% and Taxes 4% Gross Receipts.

	Return. 5%	8%
SYSTEM NO. I.		
Generating cost per kw.-hr. at plant	1.91c	2.16c
Generating cost per kw.hr. delivered to customers' meters	2.94c	3.33c
Distribution cost per kw.-hr. delivered to customers' meters	2.57c	2.94c
Metering cost per kw.hr. delivered to customers' meters	0.81c	0.89c
Total average cost per kw.hr. delivered to customers' meters	6.32c	7.16c
	Return	
SYSTEM NO. II.	5%	8%
Cost per kw.-hr. at sub-station switchboard	2.25c	2.25c
Sub-station per kw-hr. delivered to customers' meters	3.21c	3.21c
Distribution cost per kw.-hr. delivered to customers' meters	2.19c	2.54c
Metering cost per kw.hr. delivered to customers' meters	0.94c	1.03c
Total average cost per kw.-hr. delivered to customers' meters	6.34c	6.78c

It must be most clearly borne in mind that the above figures refer to the average cost per kilowatt-hour, as delivered to customers' meters, and have no direct relation to the maximum rate per kilowatt-hour to be charged some customers, or in a similar manner the minimum rate, or any rates between the maximum and minimum rates. This is manifest because every customer who requires for his service an investment and maintenance and operating charge in the cost of electric power at the substation and steam plant, or excessive expenses connected with distribution due to the small amount of current used or the comparatively high investment required to reach him in the distribution system; or as a result, also of the low load factor, must pay a rate in excess of the average cost per kilowatt-hour delivered to customers' meters, while other customers using greater quantities of electrical energy at a decidedly higher load factor than the average, with a comparatively smaller investment in the distributing system and meters, should in equity be given a rate per kilowatt-hour decidedly less than the average cost as delivered to customers' meters.

THE RANKINE CYCLE AND ENTROPY TABLES.[1]

BY ROBERT SIBLEY

Before proceeding further with the thermodynamic laws acting in the steam engine cylinder and their application in engineering practice, we come now to the important consideration of the socalled Rankine cycle and entropy.

In rules drawn up by the American Society of Mechanical Engineers for conducting steam-engine tests, it is recommended that the ratio of economy of the engine under test be compared to that of an ideal engine. The ideal engine is one which follows the Rankine cycle where steam at constant pressure is admitted into the cylinder with no clearance, and after the point of cut-off, is expanded adiabatically to the back pressure. In obtaining the economy of this engine, the feed water is, of course, assumed to be returned to the boiler at the exhaust temperature.

In our last lecture we discussed certain laws of expansion and had for our consideration an illustration of a cycle of operations as shown in the diagram of Fig. 28. A study of the particular equations that express the curves which form the boundaries of a cycle of such operations has led to many practical and useful results.

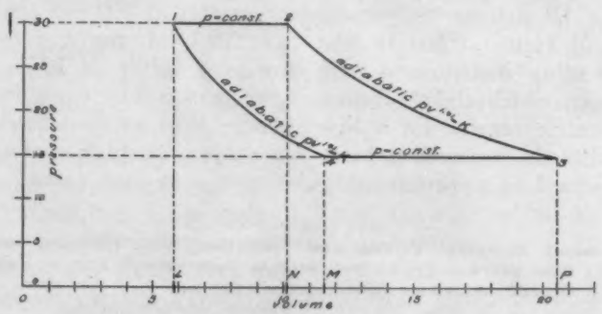

Fig. 29. The Rankine Cycle.

Thus, let us assume that our cycle starts out with a constant pressure line from 1 to 2; then continues by an adiabatic from 2 to 3; again being compressed along a constant pressure line, it returns along the line from 3 to 4 and along an adiabatic line from 4 to 1. Such a series of operations is known as a Rankine cycle and is shown in Fig. 29. This cycle as we have seen is what takes place in the ideal steam engine. For our present consideration we shall use air instead of steam. however. The quantity n in the equation $pv^n = K$, has 1.41 for its value in the case of air as we have previously seen.

Again, if our series of expansions are made up, first of an isothermal, then an adiabatic and our compressions first of an isothermal and then an adiabatic such as is shown in Fig. 30, we have the well-known Carnot cycle.

In our last lecture, we found that as the gas expanded from 1 to 2, heat must be supplied and that this heat in general performed two functions, first it raised the temperature of the gas and second it caused

[1]This paper comprises the Thirteenth Lecture of the series appearing in these columns entitled "Primer of Applied Thermodynamics," which is a resume, devoid of higher mathematics, covering the essentials of a series of lectures now being given by the editor of this Journal before the Mechanical Engineering students at the University of California.

the gas to perform external work. One of the most important conclusions found was that the area 12 N L represented this work. It easily follows, then, that the area 23 P N is the work performed by the gas in expanding from 2 to 3, 34 M P the work done upon the gas in compressing it from 3 to 4 and 41 L M the work done upon the gas in still further compressing it from 4 to 1. Hence the net work done by the gas is evidently the area in the enclosure 1234. This is a most important result and the ground-work for all indicator card representations. For it is evident that if we compute the area enclosed on an indicator card we can figure the work performed by allowing for proper scale reduction in stroke and pressure.

As engineers, however, we are interested not alone in the amount of work performed, but also in the amount of heat it has been necessary to supply to the gas in order to perform this work. Looking again at Fig. 30, we see plotted at 1 a gas which has a definite volume, temperature and pressure. We found under a discussion of adiabatic expansion in our last lecture that when a gas expands adiabatically—that is, without taking heat from an external source it will continue to do work at the expense of lowering its temperature until the temperature has been reduced to the absolute zero. Thus if its temperature is reduced from T_1 to T, the gas in expanding adiabatically would do an amount of work equal to $\frac{R}{0.41}(T_1 - T)$. If now,

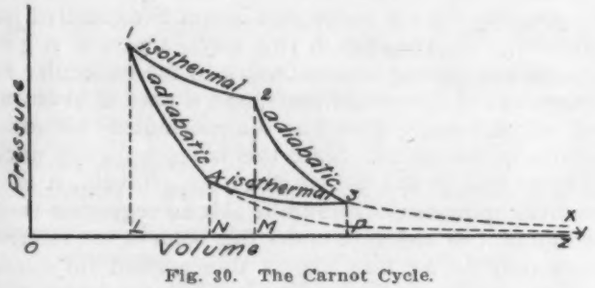

Fig. 30. The Carnot Cycle.

T becomes reduced to zero, the greatest amount of work we can possibly hope for under most ideal conditions would be $\frac{R}{0.41}T_1$. Hence the area 14 Y Z L is the total quantity of heat reservoired in the gas at 1. Now when heat is supplied and the gas expands to 2, it has a new reservoir of energy similarly computed and equal to 2 X Z M and since it has done work equal to 12 M L, evidently the necessary heat to be supplied to accomplish this must be represented by the area 12 X Y 4. In other words the heat supplied between two points is always represented on a pressure-volume diagram by area between the curve connecting the two points, the two adiabatics drawn through these points and extended infinitely to the right of the expansion line.

It is evident, however, that such a diagram is not practical as we can not measure with any known instrument an area extending infinitely beyond our diagram. The necessity early became apparent to engineers to devise some other form of diagram that would correctly represent the heat supplied and that could be readily computed with ordinary area measuring instruments. As a consequence the socalled T N or temperature-entropy diagram was invented. Let us cast about and see if we cannot invent some diagram to correctly represent the heat supplied. Let us choose absolute temperatures for vertical distances or ordinates and let us call the horizontal distances a new quantity—say call it entropy. These horizontal dis-

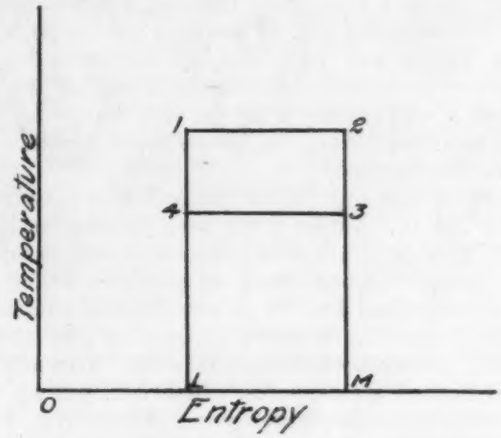

Fig. 31. A Typical Temperature Entropy Diagram for the Carnot Cycle.

tances must be of such a nature that the area enclosed between the curve, the entropy axis and any two temperature ordinates will always represent the heat supplied, in changing the state of the gas from the first temperature to the second. Fig. 31 shows the appearance of our Carnot cycle shown in Fig. 30 on a temperature-entropy diagram. Thus, since in going from 1 to 2 on a Carnot cycle our gas expands on an isothermal or equal temperature curve the straight horizontal line 1 2 will represent correctly the first expansion and the area 12 M L the heat supplied. Since the gas continues to expand next from 2 to 3 along an adiabatic or no heat supply curve no area must be shown, hence a downward straight line to 3 correctly represents this line. Again under compression the lines 34 and 41 are similarly traced, and the area 1234 represents, then, the net heat supplied. It is shown in works on calculus that when a gas expands isothermally—say from 1 to 2 in Fig 31, the horizontal distance on the curve or entropy is coumputed from the expression $R \log_e \frac{V_2}{V_1}$.

By referring to the figure it is also seen that in going from 1 on the adiabatic line 14 L it makes no difference whether we wind up at 2, 3 or any other point on the adiabatic line 23 M the distance L M or the entropy is the same. This has most important applications in the steam engine and the steam turbine operation. Thus, it is shown in works of calculus that the entropy of a liquid which Peabody designates in his tables as θ is equal to $\log_e \frac{T_2}{T_1}$, and the entropy of a vapor $\frac{L_1}{T_1}$ in which $\log_e$ is the natural system of loga-

rithms, which is computed by multiplying our ordinary logarithms by 2.306, T_2 the absolute temperature of the saturated steam, T_1 is the absolute temperature of 32° F., and L the latent heat of the saturated steam.

STEAM AND ENTROPY TABLES.

We are now ready to fully understand all the data contained in the standard tables on steam and entropy. Fig. 32 shows a page from Peabody's Steam and Entropy Tables while Fig. 33 shows a similar page from Steam Tables and Diagrams by Marks and Davis. These two books constitute standard engineering practice and it will consequently be well worth our while to see what the different columns mean and how they have been computed.

Let us take Fig. 33 for example and examine the line for 231° F. Under p we have pressure in lb. per sq. in. This of course is in absolute pressures and if a steam gauge has been read to ascertain boiler pressure we must add 14.7 lb. or atmospheric pressure to our gauge reading in order to convert into absolute pressure units shown in this column. The next column is headed atmospheres. 14.696 lb. per sq. in. is equal to one standard atmosphere of pressure. Hence simply divide p by 14.696 and we obtain reading under this column, which in this case is

$$\frac{21.16}{14.696} = 1.440.$$

Under the next column headed v or s, we have the cubic ft. occupied by 1 lb. of saturated steam at this particular temperature of 231° F. This is computed from the following thermodynamic law:

$$L = T\left(\frac{\Delta p}{\Delta t}\right)(v - v_1)$$

40 SATURATED STEAM—TABLE I.

Temperature, Degrees Fahrenheit. t	Pressure, Pounds per Square Inch. p	Heat of the Liquid. q	Heat of Vaporization. r	Heat Equivalent of Internal Work. ρ	Heat Equivalent of External Work. Apu	Entropy of the Liquid. φ	Entropy of Vaporization. φ_1	Volume, Cubic Feet per Pound. v	Density, Pounds per Cubic Foot. $\frac{1}{v}$	Temperature, Degrees Fahrenheit. t
228	20.02 38	196.5	959.4	885.1	74.3	0.3363	1.3958	20.07 35	0.04983 37	228
229	20.40 38	197.5	958.7	884.3	74.4	0.3378	1.3927	19.72 35	0.0507 9	229
230	20.78 39	198.5	958.1	883.6	74.5	0.3392	1.3893	19.37 33	0.0516 9	230
231	21.17 40	199.5	957.4	882.8	74.6	0.3407	1.3866	19.04 33	0.0525 9	231
232	21.57 40	200.5	956.8	882.1	74.7	0.3422	1.3836	18.71 32	0.0534 10	232
233	21.97 41	201 5	956.1	881.3	74.8	0.3436	1.3806	18.39 31	0.0544 9	233
234	22.38	202.5	955 4	880.6	74.8	0 3451	1.3777	18.08.	0.0553	234

Fig. 32. A Leaf From Peabody's Steam and Entropy Tables.

in which L is the latent heat determined by experiment, which is seen to be 958.7 B.t.u., or 958.7 × 777.5 ft.. lbs., T is the absolute temperature in this illustration and is 231 + 459.6 = 690.6, Δp is the increase in pressure in lb. per sq. ft. from 230° to 232° or the increase for Δt = 2 and is seen to be 21.56 × 144 — 20.77 × 144 = .79 × 144, v is the unknown quantity desired and v_1 is the volume in cubic ft. occupied by one lb. of water, which is .016 cu. ft. Hence substituting

$$958.7 \times 777.5 = 690.6\left(\frac{.79 \times 144}{2}\right)(v - 0.16)$$

$$\therefore v = \frac{958.7 \times 777.5 \times 2}{690.6 \times .79 \times 144} + .016 = 19.05$$

The next column is the specific density of saturated steam or the weight of 1 cubic ft. of saturated steam at 231° F. It is evident that since 19.05 cu. ft. weigh 1 lb., then

$$\text{Density} = \frac{1}{v} = \frac{1}{19.05} = 0.0525 \text{ lb.}$$

Under the column headed heat of liquid, known as h or q, we have the amount of heat required to raise one lb. of water from 32° F. to the particular temperature under consideration. This has been determined by experiment. Evidently if exactly 1 B.t.u. per degree was required, 199 B.t.u. would be necessary. As touched upon in preceding lectures, however, it requires slightly more than this or 199.2 B.t.u. in this instance.

The L or r column is seen to be the latent heat of evaporization which is experimentally determined and in this case equal to 958.1 B.t.u. The total heat column H is the sum of the data in the h and L column and in this case is seen to be 199.2 + 958.1 = 1157.3 B.t.u.

Table 1: Temperatures

Temp. Fahr. t	Pressure lbs. p	Pressure Atmos. —	Sp. Vol. cu. ft. per lb. v or s	Density lbs. per cu. ft. 1/v	Heat of the liquid h or q	Latent heat of evap. L or r	Total heat of steam H	Internal Energy B.t.u. Evap. I or ρ	Internal Energy B.t.u. Steam E	Entropy Water n or φ	Entropy Evap. L/T or φ_1/T	Entropy Steam N or Φ	Temp. Fahr. t
230°	20.77	1.413	19.39	0.0516	198.2	958.7	1156.9	884.3	1082.4	0.3384	1.3905	1.7289	230°
231	21.16	1.440	19.05	0.0525	199.2	958.1	1157.2	883.6	1082.7	0.3399	1.3875	1.7274	231
232	21.56	1.467	18.72	0.0534	200.2	957.4	1157.6	882.8	1083.0	0.3414	1.3844	1.7258	232
233	21.96	1.494	18.40	0.0543	201.2	956.7	1158.0	882.1	1083.2	0.3429	1.3814	1.7243	233
234	22.37	1.522	18.09	0.0553	202.2	956.1	1158.3	881.3	1083.5	0.3443	1.3784	1.7227	234
235°	22.79	1.550	17.78	0.0562	203.2	955.4	1158.7	880.6	1083.8	0.3458	1.3754	1.7212	235°
236	23.21	1.579	17.47	0.0572	204.2	954.8	1159.0	879.8	1084.0	0.3472	1.3725	1.7197	236

Fig. 33. A Leaf From Steam Tables and Diagrams by Marks and Davis.

In evaporating water into steam the socalled latent energy is expended in two ways, a part of it goes toward overcoming internal work in the molecular arrangement of the steam itself, and a part in overcoming external work caused by the enormously increased volume of the steam. Since this latter work can never be recovered in the use of steam expansively, it is of utmost importance for us to be able to segregate these two quantities and note under this column the internal work only as we may expect this portion for useful applications in the steam engine and the steam turbine. We have seen in the last lecture that external work is computed by taking a product of pressure and increase in volume. Hence

$$\text{External work in B.t.u.} = \frac{p(v - v_1)}{777.5}$$

$$= \frac{144 \times 21.16\ (19.05 - .016)}{777.5} = 74.6$$

$$\therefore p = 958.1 - 74.6 = 883.5$$

The total net energy that we may reasonably expect to use in engineering applications is the sum of this internal energy of evaporization and the heat of the liquid which is shown under the next heading entitled E.

$$E = h + p = 199.2 + 883.5 = 1082.7.$$

Under the next heading we find entropy of water which we have seen is

$$\Theta = \log_e \frac{T_2}{T_1}$$

in which $T_2 = 231 + 459.6 = 690.6$, $T_1 = 32 + 459.6 = 491.6$,

$$\therefore \Theta = \log_e \frac{690.6}{459.6} = 2.306\ [\log_{10} 690.6 - \log_{10} 459.6] = 0.3399$$

No.	Meters per sec. v	Centimeters hydraulic depth. r	log v	log r	Rough empirical equations. a	b	c	Formula normal equations n a b	b²	b c	Formula normal equations m a c	b c	c²
1	1.73	11.4	0.238	1.057	0.238 = 1.057 n + log m			.252	1.117	1.057	0.238	0.057	1
2	1.98	14.4	0.297	1.158	0.297 = 1.158 n + log m			.344	1.340	1.158	0.297	1.158	1
3	2.17	17.0	0.336	1,230	0.336 = 1.230 n + log m			.413	1.513	1.230	0.336	1.230	1
4	2.33	19.2	0.367	1.283	0.367 = 1.283 n + log m			.471	1.647	1.283	0.367	1.283	1
5	2.46	21.2	0.391	1.326	0.391 = 1.326 n + log m			.518	1.758	1.326	0.391	1.326	1
								Total.. 1.998	7.375	6.054	1.629	6.054	5.000

Solution of Darcy & Bazin Experiment (See Thermotwister No. 1.)

The entropy of evaporation is as we have previously seen simply $\frac{L}{T}$ or in this case

$$\frac{L}{T} = \frac{958.1}{690.6} = 1.3875$$

Hence the final column being the total entropy of saturated steam is

$$\Theta + \frac{L}{T} = 0.3399 + 1.3875 = 1.7274$$

Thermotwisters.

1. Take Fig. 32 which gives a page from Peabody's Steam and Entropy Tables and connect up all computations for each column as was done in this lecture for Fig. 33.

2. Work out for yourself an example in applying the temperature-entropy diagram by transforming the Carnot cycle shown in Fig. 30 on the pressure-volume diagram to the temperature-entropy coordinates.

SOLUTION OF THERMOTWISTERS—HOW TO MAKE UP EMPIRICAL FORMULAS.

1. Darcy and Bazin experimenting on the flow of water compiled the following experimental data:

No. of exp.....	1	2	3	4	5
Mean velocity (v)...	1.73	1.98	2.17	2.33	2.46
Hydraulic radius (r).	11.4	14.4	17.0	19.2	21.2

Assuming that the velocity of water in channels is of the form of $v = m r^n$, show that $v = 0.446\ r^{0.58}$ is an empirical formula for compiling the mean velocity.

$v = mr^n$. By taking logarithms, we have

$$\log v = n \log r + \log m$$

Hence the two normal equations are

$$1.998 = 7.375\ n + 6.054 \log m$$
$$1.629 = 6.054\ n + 5.000 \log m$$

Solving for n and log m, we have

$$n = 0.571$$
$$\log m = 0.366 = 1.634 \quad \therefore m = 0.431$$
$$\text{or } \log v = 0.571 \log r - 0.366$$
$$\therefore v = 0.431\ r^{0.571}. \quad \text{Ans.}$$

2. In a steam engine it is found that after cut-off takes place the pressures and volumes during expansion of the steam have the following values:

60 lb. absolute press. corresponds to 7.107 cu. ft.
50 " " " " " 8.429 cu ft.
40 " " " " " 10.39 cu ft.

Assuming the steam expands according to the law $p v^n = K$, where n and K are constants, determine their value.

Having assumed $pv^n = K$, we have taken logarithms on both sides.

$$\log p + n \log v = \log K = K'$$
$$\text{or } \log 60 + n \log 7.107 = K'$$
$$\log 50 + n \log 8.429 = K'$$
$$\log 40 + n \log 10.39 = K'$$

$$1.778 + 0.852\ n = K' \qquad 1.514 + 0.725\ n = 0.852\ K'$$
$$1.699 + 0.925\ n = K' \qquad 1.573 + 0.857\ n = 0.925\ K'$$
$$1.602 + 1.017\ n = K' \qquad 1.629 + 1.034\ n = 1.017\ K'$$

Summary coefficients:

$$5.079 + 2.794\ n = 3\ K' \text{ (A)} \qquad 4.716 + 2.616\ n = 2.794\ K' \text{ (B)}$$

Solving for n in equations A and B, we find $n = 1.07$.

THE FUTILITY OF TECHNICAL SCHOOLS.

BY R. T. CRANE.[1]

To the subject of higher schools, in all their departments, I have given much study for many years, and while I consider them all to be full of errors, deception and ignorance, the technical institutions are particularly misunderstood, and concerning them the people need to be enlightened.

This misconception of their value and importance is quite natural, as the whole subject is shrouded largely in mystery, since science is so largely connected with it, and concerning anything with which science is associated the masses have no correct opinion. They imagine that as science in the past has played an important part in the progress of civilization, this also must be the case today, which is not a fact.

What Is Science?

At the outset let me state just what I mean by "science." The dictionary definition is very long, unsatisfactory, and, in my opinion, inconsistent with the general understanding of the word.

From my view-point "science" means the doing of things in a more or less highly intellectual way by taking advantage of natural laws and principles. Take, for example, the wheel in a wheelbarrow; the lever; the block and tackle; braces and truss-building and making of caissons, etc., etc. These are some of the things that I consider to be scientific, and I believe the general public will accept this definition.

Therefore, it will be seen that many scientific principles, while exceedingly numerous, are also exceedingly simple; in fact, most of them are so considered by a good mechanic. Notwithstanding this, however, the great mass of the unthinking public seem to be overwhelmed when anything is referred to as being scientific, and to think this means it is beyond their comprehension. Hence, the great reverence they have for technical schools and for men who specialize in scientific facts as they imagine such institutions are full of these mysterious matters.

Facts.

Now, here are some facts:

First: Comparing this country today with fifty years ago; it has gone to the greatest extreme in all kinds of technical schooling. In the United States today there are 129 technical institutions including universities that have a special department devoted to this branch of schooling, and the number of students taking this course of study is about 30,000, which in all probability means that about 10,000 boys are leaving these schools each year. From this we see that there would have to be an enormous demand in order to provide places for this large number

[1]Founder and President of Crane Co., Chicago.

of young men supposed to be trained for the higher and better positions.

Secondly: It is also a well known fact that this country was immensely successful before the technical schools were established.

Thirdly: Notwithstanding many educators are trying to make us believe that this country is going to destruction through dry rot and that the only means of saving it is through their schools, the fact is that no country on the face of the earth today is more prosperous or stands so high in everything in which technical schools are pretending to aid us as the United States.

Fourthly: All the heads of these technical schools, as well as all employers who claim to favor boys from such schools, admit that before such boys can be of any value in any line of business they must have a large amount of practical training.

Fifthly: Although tens of thousands of technically school trained men have been coming from these institutions, this class of men are doing little or nothing to contribute to the real prosperity of the country, and if you should go through our great industrial institutions you would find little trace of them in any important positions; probably not in one per cent.

Importance of Experience.

What a manufacturer wants is not a man of theory, but a man of brains who has had an immense amount of experience, who knows the state of the art thoroughly, and who understands all kinds of tools and what they are capable of doing. This is the only kind of a man that is of any account in a manufacturing business.

Hence we regard these schools as absolute failures, so far as being a help to general manufacturing and industrial business is concerned, and therefore it is not necessary to discuss this feature of technical school work.

Electrical Engineering.

Having now finished my talk, so far as it relates to technical schools and mechanics or manufacturing, I will take up the question of the utility of these schools in connection with the electrical line of work, which, if anywhere, would seem to be a feature of schooling wherein these technical institutions would be much more likely to produce good results.

On this subject I am fortunate in obtaining a copy of a paper by Mr. W. M. Alexander, of the General Electric Company, in which he discusses the question of the utility of technically school trained boys in their business, and he admits, as I have previously stated, that after having employed hundreds of these boys, he finds that his method of handling them heretofore has proved a failure and he has now concluded to try a radically different one.

Mr. Alexander now sees all sorts of short-comings in the technical school boys, stating that they have a speaking acquaintance only with machines and materials, that they have no ideas as to values, etc. He also volunteers the information that other large employers who have tried the college boys in their business have had a similar experience. No doubt he has reference to the Westinghouse and Western Electric companies, as both are very large concerns and are in much the same line of business as the General Electric Company.

These three companies have been taking a very large proportion of the boys from the technical schools who secure positions upon leaving these institutions, and in view of the facts disclosed by Mr. Alexander, you can see what a frightful blunder has been made. This gentleman has a great deal to say on this whole subject, and as his paper is very interesting, I reprint at the close of this pamphlet that portion of it which relates to this particular question.

Since the utter folly of trying to make electrical engineers in this way has been shown by the testimony of one who has been an earnest advocate of the technically school trained electrical engineer, and who, after a long and extensive experience with the boys of the technical schools, has became convinced that they are utterly lacking in merit, it is unnecessary to continue the argument further.

Common Sense Method of Making Electrical Engineers

The common sense way to make electrical engineers is as follows:

Select, with the greatest care, boys about 16 or 17 years of age for machine shop apprentices. Watch over them carefully in the first instance to see that they are what the employers are seeking as material for good machinists. If the foreman who keeps close eye on the boys discover that some of them have unusual ability, let such be put in the line of direct training for electrical engineering. Such boys, after having two years of training in the machine shop (say one year at bench work and a year at tool work), shifting around considerably, would get the knowledge of that part of the work which is required to make of them good electrical engineers. Then let them spend six months in the testing department, six months drafting, a year in the erecting department and a year in the operating department.

While working in this way they are surrounded constantly by an electrical atmosphere and will absorb, through observation and association, nine-tenths of all the knowledge they will need to have regarding electricity, and all this will have a splendid influence over them. The grandeur of the work is particularly inspiring, and the absorbing of all this information takes none of their time, as it is done unconsciously.

During this period the boys could attend night school as much as is necessary and be furnished books on the science of different lines of electrical apparatus, books containing only such things as the best practical men know to be essential. If necessary, lectures could be given advantageously by the company's own engineers who know decidedly better what these boys require than any school teacher could possibly know.

This would make five years in all, and then you would have a young man who, at 21 or 22 years of age, would be a fairly good electrical engineer. Such a man is likely to make his mark and certainly should be of considerable value to any one requiring his services. Besides this, he would have been earning his living all this time.

Great Electrical Engineers.

Before leaving this feature of the subject, let me call your attention to the fact that none of the greatest electrical engineers this country has had ever saw the inside of a technical school where electricity was taught. I shall not undertake to name all of these men, but among the list will be found Edison, Sprague, Brush, Rice, Westinghouse, Thomson and Hueston.

This being the fact, is it not perfectly clear that the very best kind of electrical engineers can be produced by following the plan just outlined? In other words, this is the distinction between theory and common sense, or between higher schooling and higher education.

College Authorities Sharp-Practice Men.

As you grow older you will discover that there are many kinds of sharp-practice men, each of whom has his own way of bleeding and defrauding the people in order to make his money, that is, to steal your money. The man who picks your pocket, the man who robs you, the burglar who enters your house, or the trusts that are mulcting you on every side are all decidedly vicious, but they are insignificant thieves compared with the man who induces you to spend your money and eight or ten of the best years of your life in acquiring something that will be of little or no value to you. You can overcome, perhaps, the loss of the money which these things have robbed you of, but you cannot afford to be robbed of the years which should be employed in laying the foundation of your future career by which you can support yourself and family.

In Conclusion.

Criticisms upon my method of dealing with this subject have been made, and there comes to me a recent instance of a young man of fine character and excellent home training, who, in an unguarded moment, while in the employment of the postoffice department in Chicago, took one dollar from a letter, and was sent to the penitentiary for one year.

If it was justice to punish this young man by committing him to the penitentiary for his act, what should be done to the people who are using every possible effort to induce boys to spend eight of the best unfolding years of their lives in securing a training which will be of no practical value to them in later years?

Therefore, I have no apology to offer for what any one may call the harshness of my views.

INVESTIGATION OF CORPORATION EDUCATIONAL CLUBS IN NORTHWEST[1]

BY JOHN B. FISKEN.

The only two companies reporting any steps looking toward the education of their employees, or clubs for their benefit, are the Portland Railway, Light & Power Company and The Washington Water Power Company.

The Portland Railway, Light & Power Company state that for a number of years past it has been the policy of the company to have regular monthly meetings of station operators in order that subjects concerning the operation of the various stations might be discussed in general so that each man might become thoroughly familiar with the system. Such subjects are taken up as will be of special interest to station men and will apply to their work, and of course the purpose of these meetings is to instruct the men as much as possible and arouse their interest in their work. It has recently been decided to enlarge the scope of these meetings somewhat and include not only the station operators but also men in the underground department and in the line department.

The Washington Water Power Company has furnished and maintains a technical library, located in the main office building, for the use of all its employees. A regular librarian is employed. At the present time the library contains about 550 volumes and 900 pamphlets and catalogues. Thirteen technical journals are received regularly and placed on file.

A club has been organized of all employees interested in line work construction and maintenance. Meetings are held twice a month, when papers on various subjects are presented and discussed.

One of the main objects of the association is to remedy faulty construction and to arrange for the adoption of forms of standard construction. To this end a committee on "Standard Construction" reports at every meeting and its recommendations are carefully discussed and gone over before adoption.

The company makes a practice of advancing their workmen as their knowledge of the work warrants, as for instance in line work. When a groundman has acquired the ability to climb he is advanced to the rank of a third class lineman, climbing short poles and doing work which does not require an experienced workman. As he gains proficiency, he becomes a second class lineman, climbing any size pole and doing any work, with the exception that he does not work on "live" lines, except when helping a first class lineman. The highest class is a first class lineman, who does any kind of line work including working on "live" lines up to 4000 volts.

An Aid Department is maintained by the employees of the company, whereby the members are given medical or surgical attention in case of illness or accident. It is governed by a board of managers, of which the general manager of the company is ex officio, a member and chairman. The superintendent of the street railway system, superintendent of the light and power system and the treasurer of the company are ex officio members. The board is composed of seven members, elected annually from the various departments, who hold office for one year. The department is supported by dues paid by all officers and employees of the company pro rata according to their monthly compensation.

The Seattle Electric Company have a technical club amongst its employees, which meets at regular intervals in a hall provided and furnished for the purpose, and connected with this hall, maintain a library and laboratory.

[1]Abstracted from a paper presented before the Northwest Electric Light & Power Association, Spokane, Wash.

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Proposed Interurban in Northwest

Several items of interest have recently appeared in the news column of the Journal regarding the proposed electric line across the Flathead Indian Reservation in Montana. This reservation was thrown open for settlement some two years ago. Only those who have travelled in person across this beautiful fertile valley, hemmed in by protecting mountains, can appreciate the exquisite beauty of it all.

Two cities of promise in Western Montana have long since cast jealous eyes at each other as to which one would hold the key to the development of this promising country. Missoula on the south has completed an electric service to two of her suburban resorts and flirted with a forty mile extension still further southward in order to develop the land of the McIntosh red apple which reaches its greatest development in this famous section, known as the Bitter Root Valley.

Of course such projects as this Flathead Indian Reservation line or even the Bitter Root Valley extension can not under any possible estimation of present population or tonnage carried be shown as an actual dividend-payer. Any city, however, that will doze away while an empire in embryo as fruitful and as large as the whole of Japan awaits enterprising development, is liable to awake some day, like Rip Van Winkle, to see the progress but only to realize others have long since taken possession of the march of progress.

Rate Fixing

The data found elsewhere in these columns regarding the fixing of rates for electrical lighting in two typical Pacific Coast cities is interesting. It represents the application of the rulings of the well-known and thoroughly admired Wisconsin Railroad Commission applied to western municipalities.

A careful consideration of the data presented by Professor Cory in this excellent article brings out a very interesting point; namely, that a proper and equitable distribution of charges should not only take into account the load factor or proportion of power actually used by the consumer to the maximum demand he may to the limit of the capacity of his installation at any time make upon the power company, but the time of day during which such demand is made, is of utmost importance. The old saying of "sheep follow sheep" seems to be thoroughly in keeping with power consumption. Everybody seems to want light about the same two hours of the evening, consequently this very fact has necessitated the call for the enormous auxiliary turbo-generators with their costly equipment now in construction or in operation in Los Angeles, San Francisco, Oakland, Portland, and other cities of the coast. A careful analysis of these conditions in the article referred to will enlighten the layman greatly as to why a large hydro-electric company can profitably sell power for one cent per kw.-hr. if used continually under full-load conditions and yet the same power company may lose money when selling at six or eight cents per kw.-hr. under spasmodic peak load conditions. In Southern

California there seems to be a strong realization of up-to-date methods in working toward a more even power distribution throughout the hours of the day and night. Exceedingly tempting rates are offered —and offered on a sound business basis, too—for those using power during other hours of the day than at peak load time. In one instance four sets of rates are offered at different hours during each twenty-four hour period, the cheapest being for those who consume power during the so-called "grave-yard shift" or hours from midnight through the early morning watches. The result is that large storage battery equipments are being installed by the railway companies to corral electric energy at these periods and at the same time those using power for pumping purposes find it profitable to inconvenience themselves at off peak hours.

Another interesting deduction brought out is that relating to the ruling of the commission in the way of depreciation, taxes and interest charges for municipal plants. The Journal does not wish to be put on record by either favoring or opposing in general municipal ownership, as we believe that each individual case must be thrashed out on its own merits. It is true, however, that many partisan statements gotten up by over-enthusiasts for municipal ownership materially warp the earnings of municipal plants out of all proportion by neglecting to deduct a proper factor—which in most cases is a very large proportion of the annual earnings—for depreciation, taxes and interest.

The Wisconsin commission has put itself on record in a number of cases showing beyond question that it is only just and proper to annually provide for depreciation whether the plant is owned by the municipality or not. Again, whether or not taxes and interest are actually paid out in case of the municipally owned plant, it is only proper to make this charge in fixing the rates, otherwise the consumer is obtaining an unjust low rate for his power at the expense of the taxpayer.

As years pass by and as there is brought about a clearer understanding of the intricate laws of rate making, those who have thought the public service corporations so grasping in their socalled exorbitant charges must admit that ever widening investigation shows a justice for much higher rates than formerly thought equitable, and they must admit that when the corporations held to their theories with bulldog tenacity they not only practiced the Darwinian law of self-preservation as being the first law of nature among lower animals, but now that those theories are shown to be just and proper they must admit those high in the council among corporations are in some instances, at least, almost human.

A Reply to Richard T. Crane

Someone has said that a plumber is the only man that enjoys the exquisite pleasure of drawing down one dollar and twenty-five cents an hour for the privilege of sleeping under a bathtub. Be this as it may, the abstract of an article on the futility of technical schools appearing elsewhere in these columns, appears to our western way of thinking so unjust, so uncalled for, we cannot pass it by without a word of protest. The founder and president of Crane Co., the writer of this article, and though perhaps the greatest manufacturer of plumbers' supplies, evidently never slept many hours during the work day or he never could have become the captain of industry that he is today.

Copies of the article referred to have been sent by someone to practically every technical student in our western schools. We regret, we could not print the article in full.

There is much food for thought in Mr. Crane's criticism and yet we feel his vitriolic spleen vented against those engaged in teaching in these higher branches of education is absolutely uncalled for. Undoubtedly there are individuals deserving the criticism, but the great mass of our American engineers devoting their life energies to this work are worthy of the highest praise and consideration for their unselfish and conscientious devotion to their work.

We cannot agree with Mr. Crane's views or results of investigation at all, at least so far as western university men are concerned. In the West constructive features rather than the manufacture and design of machinery engage the attention of the engineer.

Mr. Crane boasts of fifty-seven years in the harness and consequently his qualifications to pass judgment. Some of us have not been fortunate to run our course in life to this extent as yet, nor have we had the exquisite pleasure of attaining the industrial and material success that he has, but yet in our small way we feel qualified to speak from the other point of view—from the point of view of one of those who has gone through the awful socalled blunder of taking a college course and who has gone up against the "hum-bug," "sharp-practice" men known as college professors. Shades of Benjamin Franklin! what visions of protest before our mental view!

Lack of space causes us to pass by a consideration of the unprecedented success of the technical graduates of Stanford, California, Washington, Montana, and our other well-known western institutions. The roll-call of the mines, the power plants, and the legislative halls amply boast their prowess, and even the presidency of the great republic immediately to the south gratefully pay tribute to California. The one thing which seems so utterly forgotten in Mr. Crane's article is the human side of life. The entire criticism seems to smell of a dollar and cent comparison. For our part we believe that in addition to efficiency the question as to whether better, truer, nobler citizens are being put forth should be the final criterion for or against our technical schools. Many of us have gone through the four years of socalled useless studies decried against, have shoulder to shoulder seen the manly struggle, seen the high ideals imbibed and the better, finer grip on life engendered and though we may never become great captains of industry we know we have an inner something, an inner heart-string that has been touched which all the weary grind of the shop, all the painstaking instruction of the foreman as outlined by Mr. Crane could never give us and without which life at best must be but a natural drudge devoid of the higher conception we know it has.

PERSONALS.

C. L. Cory, consulting engineer and rate expert, is at Seatttle on business.

R. W. Van Norden, a consulting engineer of San Francisco, is at Tacoma on business.

Fred Barringer is at San Francisco representing the Barry-Wehmiller Machinery Company of St. Louis.

H. Homberger, consulting hydraulic engineer, has returned to his San Francisco offices from Los Angeles.

Harry T. Hays, purchasing agent for the Mount Whitney Power Company, was at San Francisco from Visalia during the past week.

Edward G. Dewald, hydraulic engineer, joined the sales staff of Pierson, Roeding & Co., on December 1, with headquarters at San Francisco.

E. P. Waller, assistant to H. E. Barry, manager of the General Electric Company's railway department, is visiting the company's San Francisco office.

R. L. Phelps, Pacific Coast manager for the Safety Insulated Wire and Cable Company, has returned to San Francisco from a trip throughout the Northwest.

C. H. Holley, of Lindsay, who is secretary of the Tulare County Power Company, has been at San Francisco for several days closing up electric power contracts.

F. W. Wachter, who has independent long-distance telephone interests in Southern California, is at San Francisco conferring with officers of the Home Telephone Company.

Sidney Sprout has returned to San Francisco after a trip to Siskiyou County in connection with the extensions of the Siskiyou Electric Light and Power Company's hydroelectric system.

John T. Giblin of the McGuire-Cummings Manufacturing Co., Chicago, was a recent San Francisco visitor, representing his company in their bids for the Geary-Street railway equipment.

Charles Manley, former manager of the Crescent City Light and Water Company, who now has an electric lighting plant of his own, has been spending a few days at San Francisco.

W. R. Dunbar, of the detail and supply department of the Westinghouse Electric & Manufacturing Company, has returned to the San Francisco office after spending six weeks at East Pittsburg.

William C. Getz, Signal Service at Large, U. S. A., has left Chicago, Ill., for Manila, P. I., where he will take charge of the construction of wireless telegraph stations and apparatus in the Philippine Divisions.

S. G. McMeen, formerly general manager of the Bay Cities Home Telephone Company of San Francisco, has been elected president of the Mt. Hood Railway & Power Company and has established his headquarters at Portland, Ore.

Geo. J. Henry Jr. and Wm. Ward of the Pelton Water Wheel Company were at Los Angeles during the past week in connection with the opening of the bids on the waterwheels for the power plant of the Los Angeles aqueduct.

Glenn C. Webster, manager of the engineering department of the National Electric Lamp Association, made an exceedingly interesting and instructive talk at the preliminary electrical league meeting in San Francisco on November 28th.

Henry T. Scott, president of the Pacific Telephone and Telegraph Company, gave a large luncheon at the Hotel St. Francis last Tuesday, with Theodore N. Vail, president of the American Bell Telephone and Telegraph Company as the guest of of honor.

W. C. Wagner, electrical and mechanical engineer of the Northwestern Improvement Company, has accepted a chair in the department of electrical engineering of the University of Washington, for the coming year, substituting for Dr. C. E. Magnusson, who is absent on leave.

Stanley Walton, manager commercial department of the Pacific Gas and Electric Company, left on the 1st of December for Chicago, where he will attend the National Irrigation Congress. Mr. Walton is collecting much valuable data on power consumption and costs for power used in pumping for irrigation.

M. D. Spencer, who has been the manager of the Oregon Power Company at Eugene, Oregon, for the past two years, took charge of H. M. Byllesby & Co.'s electric plants at Everett, Snohomish and Monroe, Washington, on December 1. His successor at Eugene is R. M. Jennings, who is leaving the management of the Byllesby plants at Marshfield and Coos Bay.

C. F. Elwell, chief engineer of the Federal Telegraph Company, has returned to San Francisco from an extensive trip in the Northwest, where he made arrangements to establish several Poulsen wireless stations. The Medford and Portland stations are now completed and in commercial operation, giving wireless communication as far east as Fort Worth, Texas.

OBITUARY.

George W. Hebard, acting vice-president of the Westinghouse Electric & Manufacturing Company, died at his home in New York City, on Friday, November 17th. Mr. Hebard

George W. Hebard

was born in Barre Center, Olean County, New York, in 1845, and was, therefore, 65 years of age. He had been in poor health for some time previous to his death.

The death of Mr. Hebard is the third one to occur in the last few months among the higher officials of the Westinghouse Electric & Manufacturing Company, residing in New York; the others being Mr. Edward St. John, treasurer, and Mr. Robert Mather, chairman of the board of directors, the latter's death a few weeks ago having been a great shock to his wide circle of acquaintances.

ELECTRICAL MEN PLAN A CLEARING HOUSE.

The most widely representative meeting of electrical men ever held on the Pacific Coast convened at luncheon at Tait's Cafe in San Francisco on November 28. Mr. S. J. Lisberger presided as chairman and after briefly summarizing the recent efforts to bring about a mutual spirit of co-operation among the many electrical interests there represented, introduced the several speakers with a few appropriate remarks.

Albert H. Elliott, the first speaker, stirringly outlined the advantages of co-operation and in a most eloquent manner paved the way for much of the meeting's subsequent action. He traced the development of the get-together spirit through past ages and urged that the electrical men of the Pacific Coast do likewise in the broad spirit of helping the public to a better understanding of the uses of electricity.

W. S. Hanbridge, secretary of the Electrical Contractors' Association, spoke of the need for co-operation between the manufacturer, jobber, central station and contractor, and pledged the active support of the electrical contractors in furthering this plan.

Glenn C. Webster, manager of the engineering department of the National Electric Lamp Association, gave the gathering an account of the work of similar electrical leagues in the East. He stated that one of the fundamental laws for success is in giving the greatest good to the greatest number. In the electrical business this must include the consumer, perhaps the most essential element in the electrical body, and as such entitled to every consideration. Recognition of this fact is embodied in the substitution of McAdoo's phrase. "the public be pleased," for the unfortunate expression accredited to Vanderbilt.

In conclusion Mr. Webster said:

"It is very true that men who don't get together don't know each other. I believe it is a recognized fact that men who have striven alone if they have been able to rise to a position it was because there must have been a great amount of good in these men. If you will get together, if you will know each other and will honestly try to work out the problems that will come before you, you will say that unity is alright.

"It seems to me as we sit here every man is a brother in the electrical fraternity and can go out and create public sentiment on the line of fundamental truth. Even this number of members could almost mould sentiment for electricity. How are you going to get at this? Any movement that amounts to anything takes a lot of work. It takes "man hours." If the Electrical League, if you would call it that, is going to work it is going to take "man hours" to do it. You are going to get pay for those hours. When a man gets so busy that he can't attend to business he is going to drop out of the race. In order to get the fellows to work I say get them something to do. Committees should be appointed such as a public policy committee, street lighting committee, power committee, publicity committee, with the idea of having something for the fellows to do, so they would feel they were a part of the body. You bring out men you don't know in this way. It also lessens the work of the officers. With this viewpoint in mind I believe the field here is large."

Geo. C. Holberton, manager of the San Francisco Gas and Electric Company, assured the enthusiastic endorsement of this project by his company and incidentally spoke of the easy manner in which several minor obstacles might be removed.

T. E. Bibbins, manager of the General Electric Company's San Francisco office, likewise approved the proposal and pledged the support of the General Electric Company.

W. W. Briggs of the Westinghouse Electric and Manufacturing Company, in his usual happy manner, advocated that the electrical men cease their small bickerings and "get together, all the time, for everything electrical."

Chairman Lisberger then stated that the proposition depended upon the wishes of those present. Action was immediate and enthusiastic. In quick succession it was decided to form an electrical league and for that purpose the original committee, consisting of S. J. Lisberger, H. V. Carter and E. B. Strong, were empowered to select seven others to act as a general committee to report at a meeting on December 12. At that time a constitution and by-laws will be presented and suggestions made for officers and committees. Due notice of this meeting will appear in these columns next week and every electrical man of San Francisco is earnestly invited to attend.

The following were in attendance at this preliminary meeting:

Glenn C. Webster	Fred L. Webster	A. E. Drendell
R. M. Alvord	H. V. Carter	Garnett Young
John R. Cole	A. E. B. Ridley	W. H. Seaver
Geo. A. Sittman	Louis Levy, Jr.	H. C. Reid
H. A. Lardner	C. E. Reller	Samuel Hamilton
Wm. L. Goodwin	Edward Whaley	W. W. Hanscom
F. A. Leach, Jr.	P. C. Butte	J. N. Bachman
W. D. Kohlway	H. B. Squires	G. J. Peters
Sam Heyman	C. E. Wiggins	F. B. Gleason
H. A. Russell	L. H. Newbert	W. S. Berry
H. E. Sanderson	R. F. Oakes	T. E. Bibbins
H. T. Adams	S. V. Walton	S. J. Lisberger
N. M. Hope	G. I. Kinney	R. W. Van der Naillen
W. S. Hanbridge	C. W. Gortini	A. R. Saurman
M. D. Kirsten	Frank E. Smith	W. W. Briggs
H. C. Goldrick	F. E. Cronise	Van E. Britton
H. R. Noack	L. R. Boynton	G. B. Ocheltree
W. F. Neiman	H. W. Crozier	P. Decker
Albert H. Elliott	R. L. Waldron	R. D. Holabird
M E. Quinn	M. A. Bryte	A. H. Halloran
J. S. Baker	F. W. Watts	Robert Sibley
Jas. W. Redpath	C. D. Pierce	E. B. Strong

ELECTRICAL CONTRACTORS' NOTES.

L. R. Boynton of the Central Electric Company, took a flying trip to Los Angeles last Monday night.

Noble Powell, an electrical contractor of Stockton, spent last Tuesday at San Francisco.

Paul Butte of the Butte Engineering and Electrical Company, spent the past week at Portland.

A number of the San Francisco electrical contractors left last Friday night for Los Angeles to attend the Electrical Show which is still in progress.

The management of the new St. Luke's Hospital at Valencia and Duncan streets, are installing their own electric power plant. All of the bids are in for the electrical work on the building and the contract will probably amount to about $20,000. Louis Hobart is the engineer.

The McFell Electric Company is nearing the completion of a $17,000 electric wiring contract at Fort Miley.

The merchants of Stockton are about to install three hundred ornamental electric lamp posts on the principal thoroughfares of that city. Two electric power companies are competing for the contract of furnishing the current for the lights.

TRADE NOTES.

The government of Formosa has awarded a contract to the Allis-Chalmers Company for a completely equipped sawmill, which is to be electrically driven. Allis-Chalmers steam turbines will supply current for power and lighting throughout the large mill plant.

The Fort Wayne Electric Works has secured the contract for several carloads of induction motors and switchboard equipment, for a pumping installation for the Patterson ranch near Modesto. There will be seven or eight pumping stations. The pumps, of several different types, will be supplied by the California Hydraulic and Engineering Company.

LOS ANGELES ELECTRICAL EXPOSITION.

The Los Angeles Electrical Exposition made an auspicious and brilliant beginning on Saturday evening, November 25 and will continue to impress the wonders of electricity upon the people of the southern metropolis for the next fortnight. The Shriner's Auditorium is peculiarly well adapted to accommodate an exhibition of this character and its architectural features have been admirably utilized in emphasizing the advantages of this ideal source of light and power.

The general illumination as furnished by sixty magnetite arcs suspended from the lofty roof trusses, was supplemented by spans of thousands of green incandescent lamps entwined in evergreen. Handsome pedestals of white and gold surmounted by electric globes defined the spacious aisles and booth boundaries which allowed generous space for promenade and inspection.

Photo by Wm. C. Lloyd The Los Angeles Electrical Exposition

Most of the exhibits were calculated to appeal to the popular mind as will be noted in detail hereafter. Preliminary gate receipts indicate that this ambitious project will be as successful from the financial side as it is from the general excellence of the display.

National Electric Lamp Association had a beautiful exhibit at the right of the entrance to the main floor comprising a full line of Mazda lamps of all possible sizes, from the great 400-watt globes to the beautiful miniature and decorative lamps, and for all possible purposes, from the exacting requirements of automobile and train lighting to those of house illumination. These lamps were attractively displayed in various cases and racks. Many of them were equipped with the several makes of illuminating glassware, such as the Holophane, Fostoria, Alba, Luceo and Mello light showing the manner in which they can best be utilized. Samples were shown of tantalum and Gem lamps. This exhibit was under the personal charge of Glenn C. Webster, general manager of the engineering department of the National Electric Lamp Association and F. J. Blaschke.

The General Electric Company occupied a similar space at the left of the main entrance, filled with the many varied devices which they manufacture. These included a full line of alternating and direct current small motors for the thousand and one industrial and household purposes, buffers, polishers, razor sharpeners, sewing machines, vacuum cleaners, etc. A stock motor running continuously under water attracted considerable attention. In addition to this a number of large motors, including a R-I type with variable speed connection, automatic starters and frequency regulators were shown. Special attention was devoted to a complete line of wiring devices, sockets, and switches for the contractors' use. Various electrical measuring instruments, as well as the indicating and recording flow meter, were demonstrated. A miniature stage equipped with strip lights, flow lamp, dimmer and other accessories was used to display a number of lantern pictures. A mercury arc rectifier and stage dimmer was employed in this mechanism and an elaborate electric ballet exhibited. The usual line of fans, lamps and radiators were shown as well as an electric ozonator. The utility of General Electric cooking devices were practically demonstrated and the viands served from an electrically equipped dining room.

Woodhill-Hulse Co. occupied the adjoining booth on the main aisle with a beautiful display of lights, heating devices and the myriad household appliances such as, washing machines, vacuum cleaners, and electric irons now available. The same firm also occupied a large booth on the side in which was exhibited switchboards and general wiring supplies, as well as the special exhibits from the Standard Oil Company, consisting of a model oil pumping rig and an automobile racing device to advertise lubricating oil.

Southern California Edison Co. utilized the remaining of

the very large spaces on the ground floor. In addition to a portable substation which supplied power for all the exhibits in conjunction with a transformer equipment of the Los Angeles Gas & Electric Company, particular interest attached to this companys graphic exhibit and explanation of meter reading. Several attendants were continually in charge to explain to all consumers how meters are read and bills calculated. In connection with the magnetite arc illumination of the building the company exhibited its mercury arc rectifiers and continuous current transformer equipment which took care of the two circuits of 30 arc lights each. Direct current was also furnished to a number of exhibitors by means of a 60 h.p. motor generator set, operated in their booth.

The Pacific Electric Railway Company exhibited a model of their car and fender equipment and inside the car operated a moving picture machine showing various scenes along their lines in the vicinity of Los Angeles. They also exemplified the working of their new block signal system and the Hart automatic flag-man, furthermore exhibiting a model of their standard rolling stock and line construction.

W. B. Palmer, representing the Cutler-Hammer Manufacturing Co. and the Crocker-Wheeler Co., had a most spectacular exhibit on the main stage and gave hourly demonstration of the wonders of high frequency electric current, including electric welding and an electric chair. The Cutler-Hammer Company exhibited a full line of their heating appliances, push button specialties, magnets and starting devices. The Crocker-Wheeler exhibit included a large number of small motors and transformers.

The remaining booths on the main floor were filled as follows:

Standard Underground Cable Company exhibited a typical line of lead covered cables of all sizes, from those for burglar alarms to heavy power conductors, Davis open air terminals and Nordyke cable supports, as well as a large variety of insulated wires and cables.

Bell & Jamieson operated a large electric track bonding machine manufactured by the Electric Railway Improvement Company of Cleveland.

Wm. N. Glockner displayed a number of Wurlitzer mechanical pianos, including a mandolin sextette, harp, violin piano and orchestrian.

Western Union Telegraph Company showed a full line of telegraph instruments and demonstrated machine sending and receiving of typewritten letters.

B. F. Kieruff & Co. carried a representative display of samples of the products of their Eastern principals, including G. I. Mazda lamps, Fort Wayne transformers, motors, fans and meters, Mathias Klein & Co.'s wiremen's tools; Sprague motors and generators, Pittsburg high voltage insulators, Cutter street lighting posts, Eichhoff wire reels, Lord trolley retrievers, St. Louis Malleable Casting Company's overhead line material, W. A. Clark weatherproof and bare and covered wires and cables and the products of the Pacific Wire Rope Company.

Baker-Chase Electric Company in addition to exhibiting a full line of the Pacific Electric Heating Company's various specialties, had a most beautiful and attractive display of lighting fixtures and lamps of all kinds.

Haskins Glass Company occupied the adjoining booth with a large display of illuminating glassware.

The Home Telephone Company maintained and operated a branch exchange and telephone booth for the convenience of the show's patrons.

The Standard Electric Time Company demonstrated the operation of their master and secondary clock system.

Duntley pneumatic cleaners were demonstrated in the adjoining booth. The Globe Flour Mills operated a motor driven mill, showing the process of the manufacture of flour.

Various electric vehicles, including the Columbus, Detroit, Ohio, Bailey and Lamsden, filled the elevated platform surrounding the main floor as well as an exhibit of the electric stereoptigraph and the Los Angeles Brass Manufacturing Company.

The Kelman Electric & Manufacturing Company occupied a large space in the main hall entrance with an interesting exhibit comprising a 10,000 volt oil circuit breaker, a 30,000 volt three-pole double break oil circuit breaker, as well as a 60,000 volt ceiling type disconnecting switch and a 30,000 volt wall type disconnecting switch.

The Luitwieler Pumping Engine Company occupied an adjoining booth with several pumps varying in size from 1 to 30 h.p.. A 2½ h.p. pump was run upon a support consisting of but four water glass tumblers on a saw horse to show the lack of vibration.

Electric milking of cows proved a centre of popular attraction.

The Electrical World and the Journal of Electricity, Power and Gas displayed their publications.

The United States Government installed a most extensive series of exhibits, comprising models of early types of electric machinery from the Smithsonian Institute, and models of several warships and transports as well as a full display of guns, electric navy equipment and wireless apparatus employed by the Navy Department. On the upper floor, also, the Bureau of Standards gave a most interesting exemplification of the standardizing work being done in Washington and of their various publications. This exhibit included a large number of instruments of precision of all kinds, the primary electric standards and tubes of rare gases. The United States Weather Bureau displayed a line of weather maps and forecasting instruments.

Other exhibits on the upper floor included the following:

United States Electric Manufacturing Company displayed a line of small motors, generators, transformers and switches with an attention-compelling high frequency apparatus

J. C. Farrar & Co. had an attractive exhibit comprising E. E. E. pipe frame fittings, cable end bells for outside and inside service, bus bar supports, air boxes and transformers, water bells, a full line of Swartout steam specialties, including separators, exhaust heads and building ventilators. They also demonstrated the Electro-Magnetic Tool Companys electric hammer and showed a line of lightning arresters manufactured by the Lord Manufacturing Co.

John A. Roebling Sons Co. showed bare and insulated covered wire and cables and wire rope.

The Southern California Electric Company displayed an interesting model of the Mt. Lowe electric railway and demonstrated various electric toys, heating devices, washing machines, vacuum cleaners, etc., as well as giving a full display of Monarch lamps.

Gans Bros. exhibited an interesting line of electric novelties, toys, wireless apparatus and household appliances.

Kellogg Switchboard & Supply Company made a large exhibit of telephone instruments and parts for various services and also showed the Delco automobile ignition device and Columbia batteries.

The Empire Electric Company as the successors of the Electro-Mechanical Laboratories Company, showed a general line of E. J. Rose's high frequency apparatus for physician's use and contributed to the show's popular interest by demonstrating X-Ray apparatus and high frequency freaks.

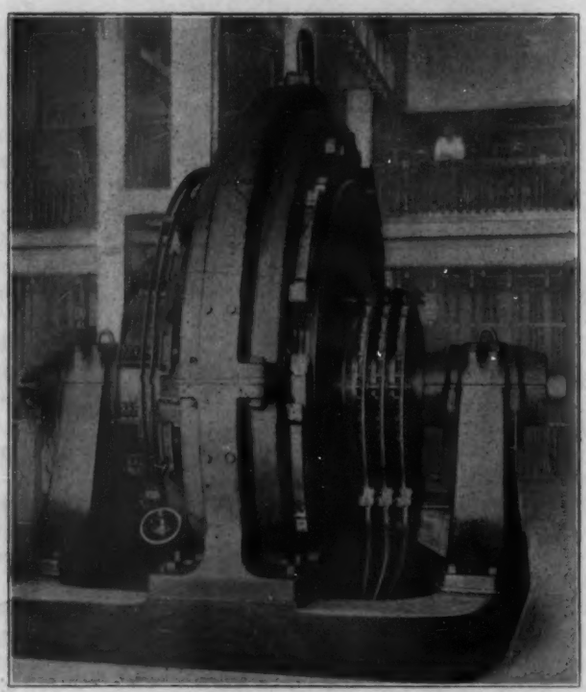
The Tuttle-Stevens Manufacturing Company showed electric ovens. The Los Angeles Silk Works operated a silk loom and made an exhibit of silks. Other exhibits comprised Tuec standard cleaners, Hobart coffee mills, the Multigraph, Dictaphone, the Los Angeles Evening Herald and electric automatic incubator.

INDUSTRIAL

3000 KILOWATT ROTARY CONVERTERS.

For the economical transmission of energy as direct current either close proximity of the generator to the point of power application, or the use of alternating current for transmission is necessary. For this reason direct current for railway service is seldom generated as such in this progressive age. The tendency is to generate all energy as alternating current in large economically located stations, and to transmit it as alternating current to sub-stations located in the section where it is utilized as direct current in the railway motors. Rotary converters because of their exceedingly high efficiency are peculiarly adapted and are usually used in the sub-stations for converting from alternating to direct current.

It is recognized that the combined efficiency of a rotary converter and its transformers is considerably higher than that of a motor generator set of equivalent capacity and voltage. This advantage in efficiency is even more marked at light loads than at full load, and since the load factor of railway systems is usually low, the inherent fitness of the rotary converter is evident.



3000 kw., 25 Cycle, 6-Phase, 600 Volt Rotary Converter for Interborough Rapid Transit Co.

The growth of traction systems has been so rapid of late in the larger cities that it has been necessary to materially increase the outputs of the sub-stations. It was desirable, and practically necesary in some cases, to do this without increasing the sizes of the sub-stations without increasing real estate investment. The Westinghouse 3000 kw. rotary converter offers the solution to this problem in that with it maximum output can be obtained with minimum floor space.

The Westinghouse 3000 kw., 600 volt, 187½ r.p.m. (25 cycle) rotary converter, the largest in output ever constructed, is being received most favorably by operating companies because of its strength, compactness, economical operation, and the minimum amount of floor space required. Rotary converters of other makes of greater bulk but of smaller output have been manufactured.

While some of these 3000 kw. rotary converters are started from the direct current end, all are designed for alternating current self starting and several will be regularly started by this method.

NEW CATALOGUES.

"Guess Which of Them Is Copper Clad?" is the title of a leaflet just issued by the Duplex Metals Company, of Chester, Pennsylvania.

The Wirt Electric Specialty Company of Germantown, Penn., has just issued Bulletin No. 1106 on di-el-ite resistance units used in the resistors covered in the patents of Charles Wirt.

The Helios Manufacturing Company of Philadelphia, are distributing through their San Francisco agency, G. A. Wilbur of 78 Second Street, their new illustrated Bulletin No. 72, which covers alternating current flame arc lamps of various voltages.

Bulletin No. 1525 of the Allis-Chalmers Company describes type AA7 compressor for air brake equipments. This machine is of new design throughout and embodies many features which show a distinctive advance over previous motor-driven compressor designs.

The current number of The J-M Roofing Salesman, one of the two house organs of the Cleveland Branch of the H. W. Johns-Manville Co., is largely devoted to pictures showing the many different classes of buildings covered with "The Everlasting Roofing."

The Allis-Chalmers Company has just issued Bulletin No. 1075 on belted alternating current generators. The pamphlet thoroughly illustrates the designs manufactured by the company. Bulletin No. 1525 deals with type AA-7 compressors for air brake equipments.

The engineering department of the National Electric lamp Association has issued Bulletins No. 16 and 17. The former deals in an instructive manner with "Mazda" incandescent street lighting while the latter recounts the economical operation of incandescent lamps.

The H. Mueller Manufacturing Co. of New York City has just issued the second exhaustive edition of their Catalogue D. The catalogue is cloth bound and thoroughly illustrates the standard specialties carried by the company among the more important of which are tapping machines, corporation cocks, water connections, lead flange work, pressure regulators and tools.

The General Electric Company has just issued Bulletin No. 4899, illustrating and describing its Expulsion Fuses and Fuse holders. These are for use on circuits having voltages up to and including 110,000. The company has also just placed on the market a new piece of apparatus known as a Battery Truck Crane, which the company describes in its Bulletin No. 4892, recently issued. The bulletin contains illustrations of the truck and crane in use, and describes also various pieces of apparatus used in connection with it.

Descriptive Leaflet 2373, issued by the Westinghouse Electric & Manufacturing Company, of East Pittsburg, Pa., describes the No. 303-A box frame interpole motor manufactured by that company. Complete specifications for the motor, brief descriptions of the important parts, and performance curves are given on the sheet. Descriptive Leaflet 2374, also recently issued by this company, gives specifications and brief descriptions of the parts of the company's box frame interpole railway motor No. 310-C. This leaflet is similar in general make-up to the one above described.

NEWS NOTES

INCORPORATIONS.

PORTLAND, ORE.—Power Plant Equipment Company of Portland, Ore. Capital, $10,000.

SANTA FE, N. M.—The Silver City Power Company has been incorporated with a capital stock of $100,000. The incorporators are: L. B. Downey, E. T. Hann, J. W. Carter.

SAN FRANCISCO, CAL.—Merced River Electric Power Company, San Francisco, $10,000,000, by L. M. Gove, H. L. Breed, C. Gross, J. E. Bowes and M. S. Hamilton.

HOOD RIVER, ORE.—The Hood River Gas & Electric Company, capital $100,000, has been incorporated by J. Flynn, Fred A. Martin and W. M. Daly. It is rumored that the new company is a subsidiary corporation of the Pacific Power & Light Company.

CASTLE ROCK. WASH.—The Castle Rock Light & Power Company, capital $250,000, has been incorporated by A. E. Braden, H. B. Davis and I. W. Belden as stockholders. The company's central offices will be established at Tacoma and will expend the sum of $10,000 on an electric light plant to furnish this town with lights.

EL CENTRO, CAL.—The Imperial Southside Water Company has been incorporated with a capital stock of $200,000. The principal place of business is Holtville and the incorporators are: C. D. Hartshorn, G. L. Melton, F. S. Best, Clark Rooher and S. B. Otter. Water will be developed and a canal built in the southeast portion of the valley for carrying an ample supply of water.

SAN FRANCISCO, CAL.—The Feather River Power & Irrigation Company, with a capital stock of $10,000,000 authorized, and purpose set forth to do business in all parts of California, November 21 filed articles of incorporation with the county clerk. R. K. Burrows of Larkspur, A. N. Lewis Jr. of Alameda, A. L. Dahl of San Francisco, H G. Hill of San Francisco and F. C. van Deinse of Berkeley, are named as incorporators.

SACRAMENTO, CAL.—Articles of incorporation of the California Telephone and Light Company have been filed with the Secretary of State. The company is a Santa Rosa concern, capitalized at $10,000,000, and operates seven miles of telephone lines. The directorate is comprised of John E. Bennett of Palo Alto, F. L. Wright of Santa Rosa, A. H. Spurr and M. S. Sayre of Lakeport, S. Pickering of Santa Rosa and H. L. Ney of Kellogg.

ILLUMINATION.

EUGENE, ORE.—The $25,000 electric light bonds recently floated have been purchased by local people. Clusters will shortly be installed on the streets.

CENTRALIA, WASH.—The Washington-Oregon Corporation has made application for a franchise to erect poles for electric light wires along the county road between Littell and Adna.

WALLA WALLA, WASH.—The Attalia Land Company has filed with the County Commissioners a petition asking for a franchise to construct electric light and telephone lines in Walla Walla, for fifty years.

OAKLAND, CAL.—Mayor Frank K. Mott has received a communication from F. A. Leach Jr., manager of the Oakland Gas, Light & Heat Co., stating that beginning with December 1 of this year the rate for electricity for lighting by meter measurement will be maximum 7c per 1000-watt hours, with a sliding scale to 3c per 1000-watt hours. The present rate is 9c graduated to 3½c.

LEWISTON, IDAHO.—This city has adopted the tungsten plan of lighting in preference to others, and has instructed the lighting company to install same.

KALISPELL, MONT.—The Northern Idaho & Montana Power Company has received a contract for the lighting contract here.

PASCO, WASH.—The proposition of purchasing the water works system and plant of the Pacific Power & Light Company was defeated at a recent bond election.

AMITY, ORE.—Amity citizens desire the installation of a city water system, and the City Council has the matter under advisement.

SANTA ROSA, CAL.—The Supervisors have passed an ordinance granting to the Pacific Gas & Electric Company a franchise for laying and maintaining gas pipes, mains and conduits in the County of Sonoma.

CHICO, CAL.—An ordinance has been passed by the Supervisors granting to the Pacific Gas & Electric Company the right to lay gas pipes, mains and conduits in the County of Butte, in the vicinity of Butte.

GLENDALE, CAL.—City Trustees have accepted the offer of L. C. Brand to transfer the Glendale Light & Power Company's West Glendale system to the city for $55,000. The system will be enlarged and improved.

MARSHFIELD, ORE.—Plans are being made for the development of a large water power plant on the South Fork of the Coquille River in this county. M. J. Anderson of Grants Pass, with his associates, owns the water rights.

MERCED, CAL.—The San Joaquin Light and Power Company is extending its work of laying new gas mains. The company intends to lay new and larger mains to all parts of the city. At the present time a force of 60 or 70 men is employed.

FALLON, NEV.—The bond issue for the purpose of raising money to construct an adequate sewer and water system has been disposed of and the money is in a local bank. Bids for the construction of the system will be advertised for within a few days.

DIXON, CAL.—The Pacific Gas & Electric Company has the material on the ground for a new substation which is to be considerably larger and much more modern than the one now in use. The structure is to have a concrete floor, iron beams and girders, the walls and roof to be of corrugated iron and the machinery to be installed in it of the latest and best pattern.

BERKELEY, CAL.—Frank A. Leach Jr. of the Oakland Gas, Light & Heat Company has notified Mayor J. Stitt Wilson that his company had voluntary reduced its rates in Berkeley. A recent ordinance put the electric rate at 8½c which the company now cuts to 7c. The gas rates have been 90c per 1000 cubic feet for fuel and $1 for illuminating purposes. The new schedule puts the rates at 90c per 1000 cubic feet a month.

TRANSPORTATION.

BLAINE, WASH.—The City Council has granted a franchise to the Nooksack Valley Traction Company for railway construction over local streets.

HUSUM, WASH.—Trustees of the Northwest Electric Company held a meeting in Portland recently to decide the question of starting operations.

LOS ANGELES, CAL.—The Board of Supervisors will receive sealed bids up to December 26th for the right to construct and for a period of 40 years to operate an electric railroad along certain public highways of Pasadena.

SAN DIEGO, CAL.—The council has voted to issue a 41-year street railway franchise to the San Diego Electric Company on F street, from Fourth to Third street, for a bid of $150. The new line will connect with Spreckels' lines.

LOS ANGELES, CAL.—E. D. Goode of Glendale, C. P. Grogan, T. Miller and residents of San Fernando are projecting an electric railway line for San Fernando, to be built under the direction of the Mission Land Company.

BAKERSFIELD, CAL.—The trustees have passed an ordinance granting the San Joaquin Light & Power Corporation a 49-year franchise to build and operate a street railway on Chester avenue, from Twenty-fifth to Thirty-fourth street. The company was the only bidder, its bid being $250.

SAN FRANCISCO, CAL.—The Board of Public Works has deferred for a week taking action on the four bids for furnishing 43 cars needed for the Geary street municipal railway. The delay was ordered at the request of the Home Industry League, the Civic League of Improvement Clubs and other organizations.

PRINEVILLE, ORE.—Mrs. L. B. Kerwood, supposed to represent an eastern syndicate of capitalists, recently stated before the Commercial Club of this place that the year 1912 would bring about the completion of an electric railroad connecting this place with the Deschutes & Oregon Trunk Railway at Metolius, to follow closely the bed of the Crooked River.

PRINEVILLE, ORE.—Louis Gerlinger Jr., general manager of the Salem Falls City & Western Railroad, and W. J. Taylor, of Portland, Ore., visited Prineville this week and went over the proposed routes for the new electric railway from Metolius to Redmond, along the line of the Deschutes and Oregon Trunk Railway. No definite statement was made, but it is known that the proposition is considered with favor, owing to the fact that there is an abundance of power in the Crooked and Deschutes Rivers for operating an electric railroad cheaply.

TRANSMISSION.

WENATCHEE, WASH.—The Wenatchee Valley Gas & Electric Company has purchased the plant of the Valley Power Company at Dryden, the deal involving something over $250,000.

DORRIS, CAL.—The bid of the Siskiyou Electric Light & Power Company for a franchise for stringing and maintaining wires in the corporate limits of the town of Dorris has been accepted.

CASTLE ROCK, WASH.—The City Council has passed an ordinance granting to H. B. Davies, J. W. Selden and the Tacoma Investment Company the right to construct and operate electric light lines within the city.

WALLA WALLA, WASH.—A 50-year franchise has been granted the Pacific Power & Light Company for setting poles and stringing wires over the streets and alleys at Attalia, where the Grinnell Company, recent purchasers of the Attalia irrigation project is now planning the installation of an electric pumping plant.

SAN BERNARDINO, CAL.—The central stations' first distributing line contract for the Southern Sierras Power Company of this city has been awarded by the Sierras Construction Company to M. H. French. The work must begin immediately and be completed before February 10, 1912. The contract price is $159 per mile.

VISALIA, CAL.—The Board of Supervisors has passed an ordinance granting the Pacific Light & Power Corporation a franchise to construct and for a period of 30 years operate an electric tower and pole and wire system upon certain public highways in the county of Tulare.

WENDELL, IDAHO.—Lafayette Hanchett of Salt Lake City, a member of the board of directors of the National Copper Bank at that place, while visiting this city, stated that work will start shortly on the Thousand Springs power plant. The enterprise is backed by controlling interests in the National Copper Bank and warrants its completion. The Westinghouse Machinery Company will furnish the power plant machinery. The plant will cost $500,000 and will generate 5000 h.p. at a cost of $500,000.

TELEPHONE AND TELEGRAPH

MARIPOSA, CAL.—The Supervisors have granted the petition of James D. Westfall and others for the erection of a private telephone line on and across the public roads of Road District No. 5.

BELLINGHAM, WASH.—The Farmers' Mutual Telephone Company is to start work on the building of a new trunk telephone line from Bellingham to Sumas, according to announcement made by General Manager Don D. Clark.

RED BLUFF, CAL.—The Tehama County Telephone Company has commenced the construction of its long-distance line, running south from Red Bluff, stringing its wires on the Postal Telegraph Company's poles. Heretofore this company has confined its operations to local service in Red Bluff and Corning and in outlying districts.

WATERWORKS.

ELLENSBURG, WASH.—Bids will be received by J. A. Crimp, city clerk, of this city, up to November 20th, for electric light and power bonds in the aggregate sum of $110,000.

BURLINGAME, CAL.—Burlingame proposes to install a municipal water system and following the recommendation of the water commission, the trustees appropriated $1000 to prepare plans. The water commission consists of Eric Langel, Victor H. Woods, E. F. Verrill, Dr. H. d'Arcy, A. M. Power and C. J. McGregor.

TUCSON, ARIZ.—The City Council and Board of Trade are busy planning for a water supply for the city. The city has plenty of machinery, but it is not properly placed, and the main supply pipes are not large enough. It is possible that a large storage and pressure reservoir may be built in the near future, especially for fire protection.

PASCO, WASH.—A contract has been awarded by the council to Evans-Dickson Company, electrical engineers, of Tacoma, for furnishing 84 ornamental street lights at $7000. The casting required will be furnished by the Olympic Foundry Company, Argo Station, Seattle, which holds patent rights on the design of post selected by the City Council.

REDDING, CAL.—W. A. Cooper, secretary of the Mount Shasta Power Company, has filed a waiver on the part of the Central Pacific Railroad Company, in consideration of $12,000 for all damages that may accrue to its property because of the diversion of water from Pit River in the Big Bend. The waiver also includes the right of way for pole lines. The point of diversion for the Mt. Shasta Power Company is three miles up the Pit from the point of diversion for the Northern California Power Company's 120,000 h.p. project. The Mt. Shasta Power Company has been doing considerable work on the quiet. Work on the tunnel that is to be 150 feet less than seven miles in length was commenced last fall and over a quarter of a mile of the tunnel has been dug. The fall at the outlet of the tunnel and canal will be 900 feet.